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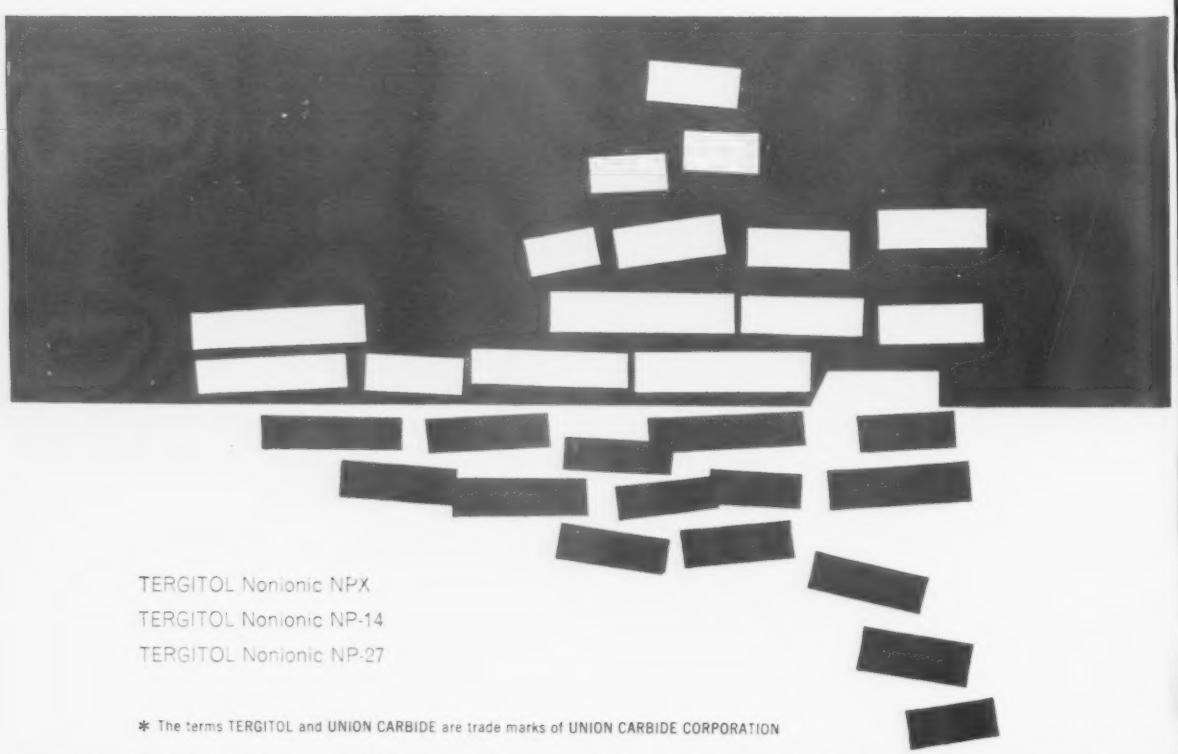

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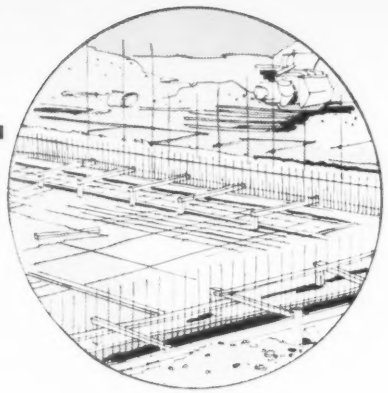

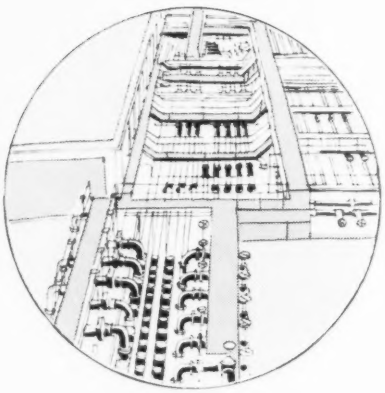

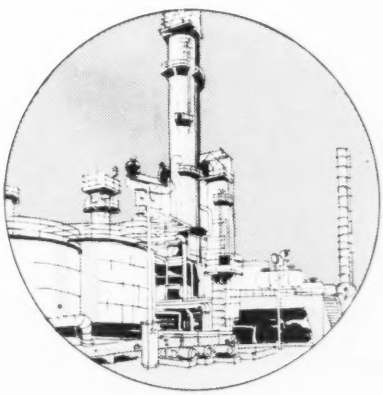

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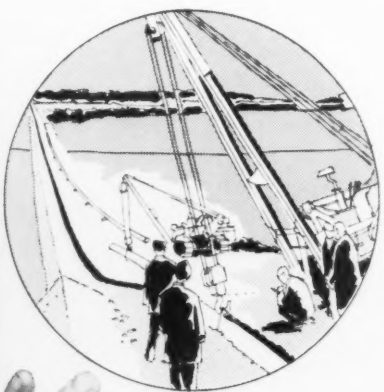

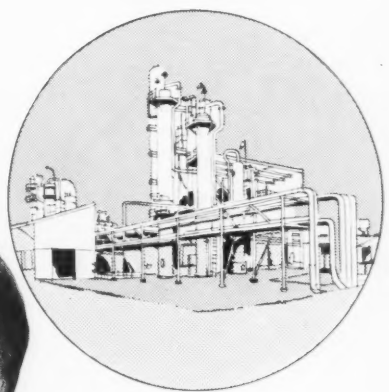

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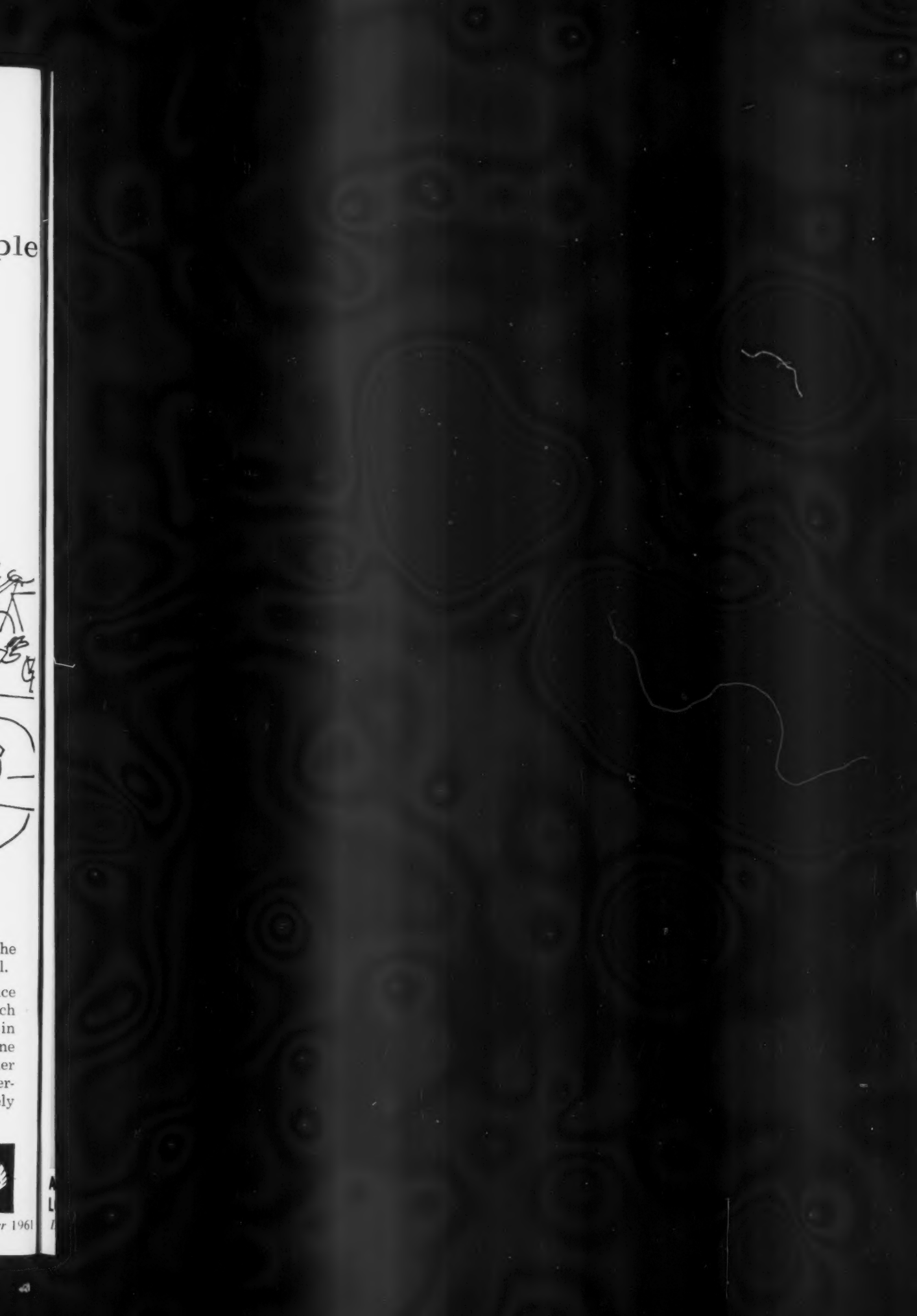

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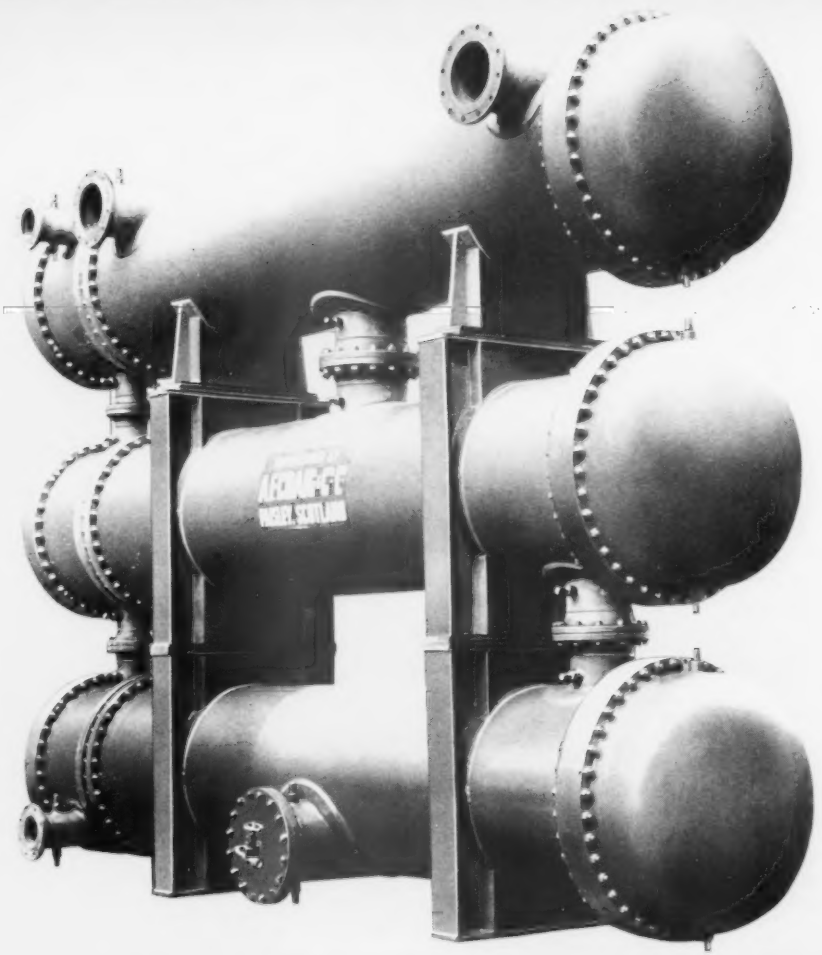

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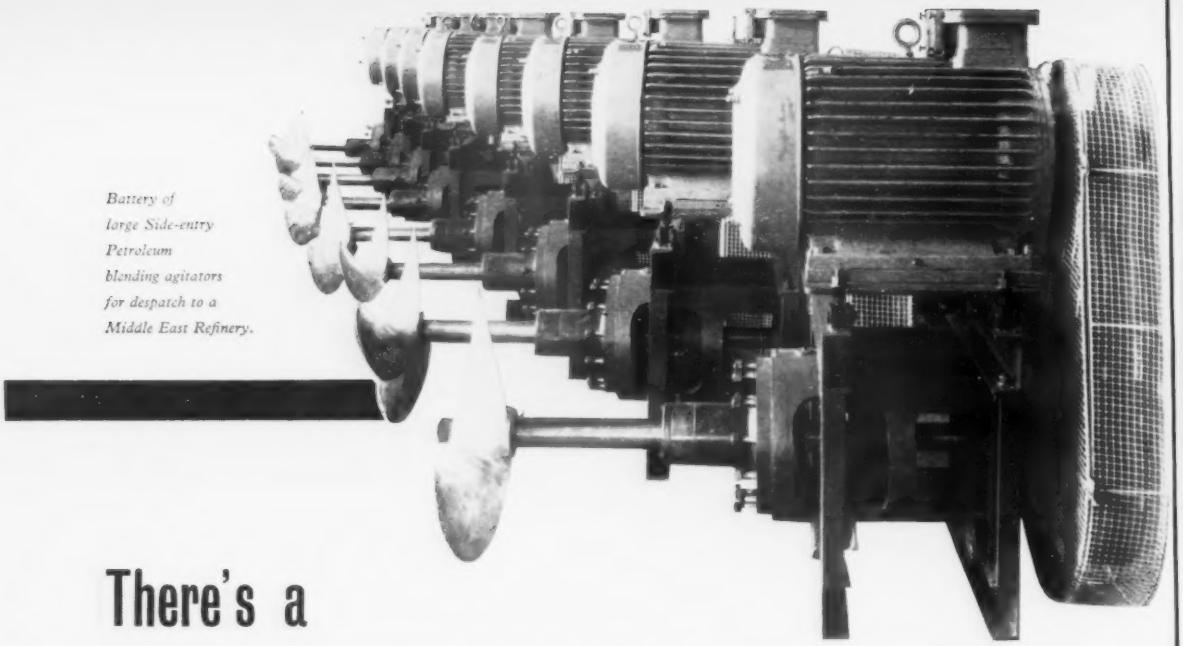

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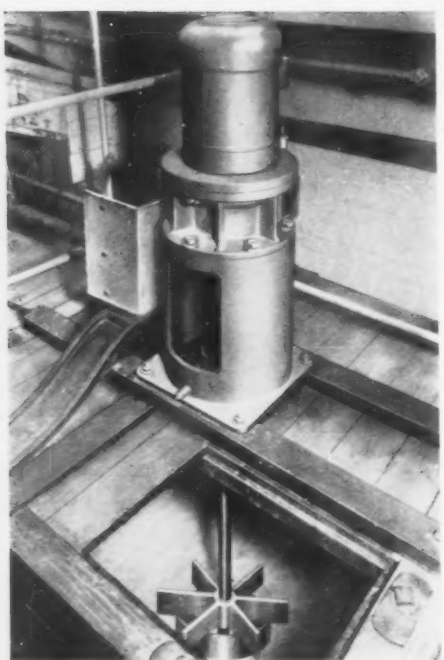

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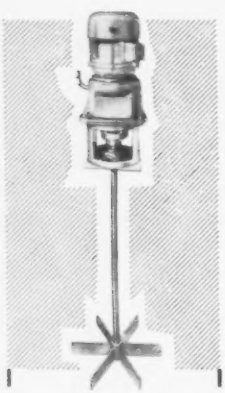

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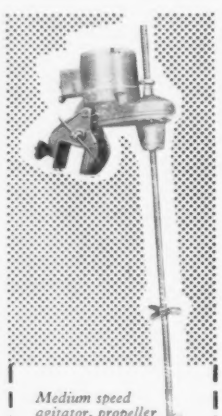

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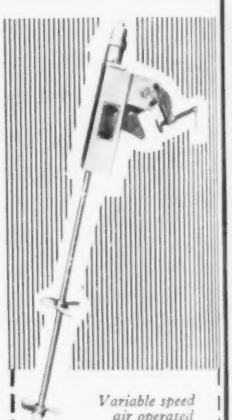

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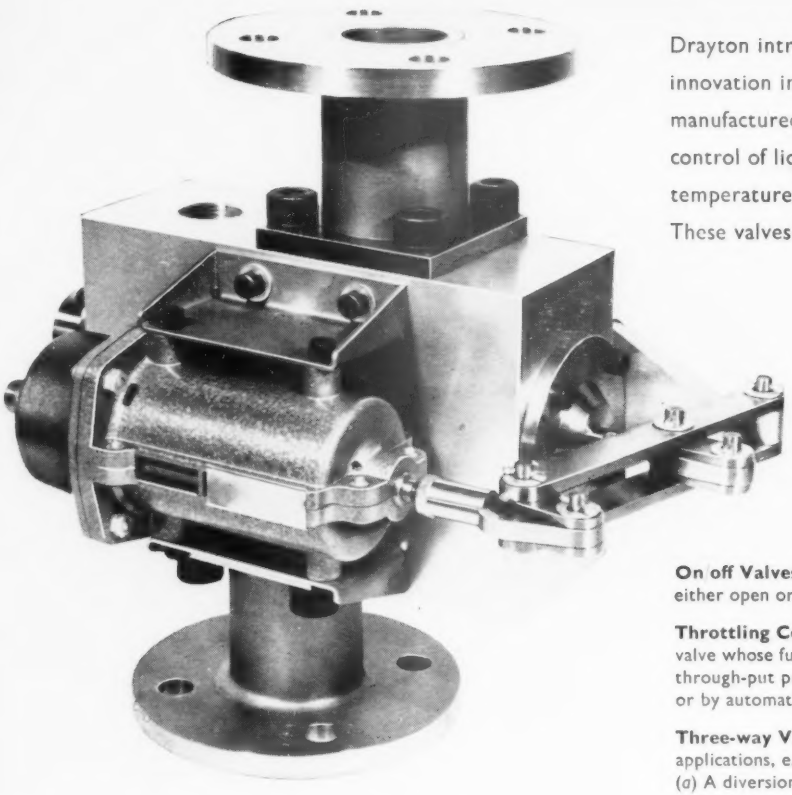

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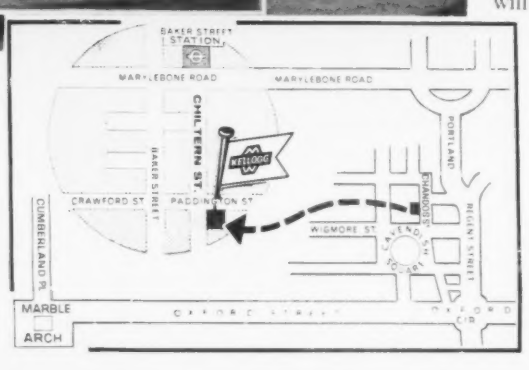


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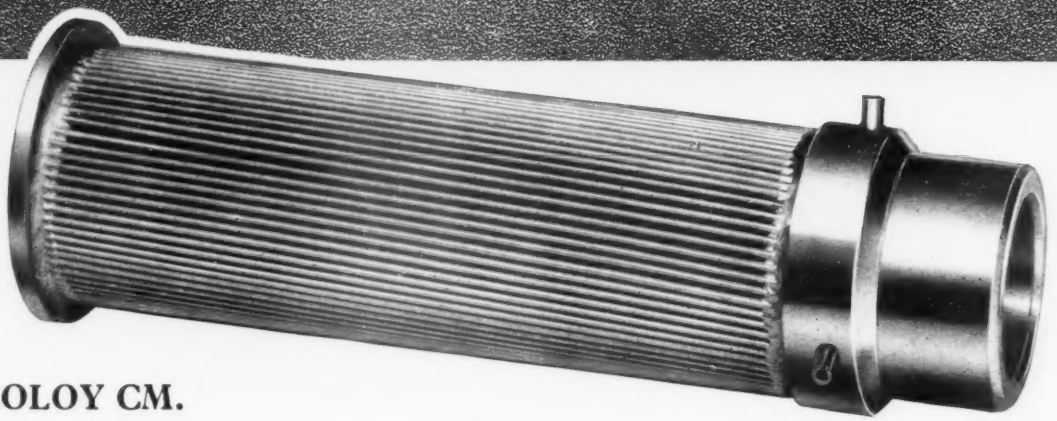

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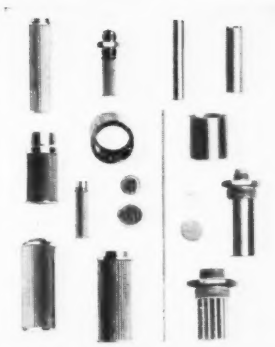

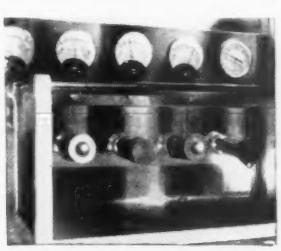

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# *The Potential of Secondary Recovery in Increasing Oil Reserves*

*By* M. STEPHENSON*

*This was the final paper presented at the IP Exploration and Production Group symposium on "Why Are Oil Reserves Continually Growing?" held at the Institute on 23 June 1961. The introduction to the symposium and the first three papers were published in the September and October issues of the IP Review*

At the end of 1960 world cumulative production of crude oil amounted to nearly 130,000 million brl. At the same time, according to widely published figures, future proven production was estimated at about 300,000 million brl giving an estimated total proven recovery of 430,000 million brl from presently known oil resources.

Estimates of recoverable oil are expected to grow in the future due to discoveries of new accumulations, and to improvements in the fraction of oil economically recoverable from accumulations once they have been found. In this paper it is intended to look at the possibilities of increasing recovery factors, in particular by means of secondary recovery methods.

The scope of the subject can be well appreciated when it is considered that the recovery of 430,000 million brl from known resources in commercially producible fields may still leave something of the order of 1 million million brl underground in those fields alone. To this very large quantity must be added the amounts of oil which occur in known accumulations presently considered non-commercial. Further must also be added that part of the oil tentatively visualized as unproducible in all new discoveries forecast for the future. An improvement in overall recovery efficiency of say only 1 per cent from known commercial fields would already be equivalent to the discovery of something like 15,000 million brl of new recoverable oil, or to 2 years world production at present rates.

It is not surprising that several authorities have given their opinions on the future prospects. Walter J. Levy is recently quoted as saying "improvement in methods of recovery could literally multiply the producibility from existing and future reserves". L. G. Weeks is more specific. Forecasting for the world as a whole an ultimate recovery by primary conventional methods alone of 2 million million brl, he foresees that as much as 1·5 million million brl may be added by secondary recovery in oilfields, and a further 1·1 million million brl from tarsands. His combined total figure for the world's ultimate oil production thus is 4·6 million million brl.

The purpose of this paper is not so much to quote specific figures; rather it is to outline the main aspects of the subject. The aim is to set into perspective by an overall review features and trends which seem significant for any appraisal of the potential of secondary recovery.

**General Aspects of Secondary Recovery**

Taking a look back into the history of the petroleum industry, it can be seen that as understanding grew of natural, or primary, oil recovery processes which occur underground, it was recognized that certain mechanisms were more efficient than others. It was gradually appreciated that certain characteristics of the crudes and of the reservoirs had marked effects on the quantities of oil that could be economically recovered. Thus, there was made a broad classification of reservoirs according to the main natural productive mechanism.

We have the solution gas drive field, where practically the only energy contributing to production is expansion of the gas originally dissolved in the oil. The mechanism is comparatively inefficient, and average recoveries in commercial fields may range from 5 per cent to, say, 25 per cent of the oil in place.

There are also reservoirs where marked gravity segregation of oil and gas occurs within the reservoir. This allows better gas-oil ratio control, and more efficient use of reservoir energy. Recoveries as high as 50 per cent or more of the

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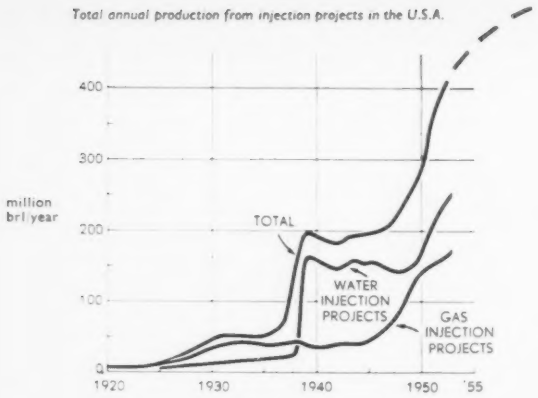



*Fig* 1

oil-in-place are reported for the best cases. Then there are reservoirs where pressure is fully or largely maintained by natural influx of water. Recovery factors as high as 80 per cent or more have been recorded in a few exceptional cases, and averages may even be around 50 per cent. In nature, of course, combinations of these mechanisms are common.

With growth of understanding in the industry, efforts were made to reinforce the more effective mechanisms and characteristics in reservoirs, or to imitate favourable features. These efforts followed two main lines. On the one hand there was the attempt to put into effect those practices which would utilize to an optimum degree the features naturally available. This was the move towards what have been rather loosely termed "sound primary production practices", an important move which is still very much under way. On the other hand was the attempt to find means of augmenting the favourable natural features by supplementary measures, or to replace an inefficient mechanism by one that was more efficient. These measures are called "secondary recovery". The name is understandable, if not too accurate.

That gas or water under pressure could move oil towards producing wells was one of the first lessons the industry had to learn. To imitate and augment this by injecting gas or water into reservoirs was an obvious next step. However, to evaluate whether injection of either gas or water, or both, could be a wise and economical step for a particular reservoir is a harder problem. There are important reservoirs where the injection of water or gas would have an unfavourable effect on the production. The industry is still learning the which and how and when of this business of secondary recovery by gas and water injection. It has gone a long way in a short time. It is safe to assert that it will go much further.

Leaving for a moment discussion of the injection of water or field gases, which methods form the backbone of present secondary recovery applications, some features of other developments may be mentioned.

The continued advance of field knowledge and experience over the years, and the progress of investigations on an increasing scale in research laboratories have brought out more clearly which are the factors that influence the recovery efficiency. The viscosity of oil underground, for instance, is a very significant feature, and may sometimes be very unfavourable. This viscosity is affected by the amount of gas in solution, and even more so by temperature changes.

The phase behaviour of hydrocarbon mixtures under reservoir conditions is of much importance; for instance, there is the phenomenon of retrograde condensation in condensate-type reservoirs. The volume of oil underground depends on the amount of gas in solution, and under certain circumstances this feature may favour displacement processes at higher reservoir pressures. Then there are the surface or contact phenomena; the capillary and surface forces can be extremely significant in some cases. Wettability and displacement by imbibition are practical problems nowadays.

In total, a rather long complex sequence of factors which have to be taken into account can be listed. Investigation of these factors has given rise to what may be roughly lumped together as the novel recovery methods, although as far as the terminology goes, generally speaking, these methods are not strictly new. Perhaps the first in commercial practice, was the cycling of condensate reservoirs. In the 1920's and 30's both Americans and Russians were sporadically active with trials of thermal recovery, and over 20 years ago we made promising experiments on the possibility of improving the recovery of suitable oils through gas injection at high pressures, to achieve high liquid volumes underground.

The novel methods already find some application. For example, condensate cycling schemes and miscible drives (injection of LPG, and similar fractions) are not so rare. However, by and large, the application of novel methods is still only found in particular circumstances, or on a pilot basis. Some of the methods have so far had more news value than commercial value! Yet the improvement of recovery methods is a tremendously important matter, and the industry views it very definitely as such. To quote from recent public reports of a few companies, relative to oil production research and development:

> "each year (larger) effort devoted to increasing the total ultimate recovery of oil (and gas) from old and new fields";
>
> "scientists and engineers learning more and more about the fundamental factors which control oil recovery processes";
>
> "finding more opportunities all over the world to take practical advantage of improved oil recovery methods";
>
> "significant progress in methods of producing oil";
>
> "advances in oil recovery techniques—providing valuable data essential to the efficient utilization of crude oil reserves";
>
> and
>
> "research focused on methods for increasing recovery of petroleum both from new discoveries and from older fields' reservoirs".

In this paper no attempt is made to appraise in particular the merits or potential applications of the novel methods on their own. For the purpose of this overall review they are included as part of the general improvement in secondary recovery now under way and anticipated in future.

So on the one hand is primary recovery, and on the other secondary recovery by both conventional and novel methods. However, the distinction between primary and secondary recovery is becoming blurred. Not only are the lessons from the one being used in the other, but secondary recovery methods are being applied more and more in early stages, long before primary recovery is far advanced. Indeed, secondary recovery techniques may well be applied in some circumstances almost from the start of production. This overlap makes distinction difficult between the oil recoveries that might be expected by primary means alone, and those by primary plus secondary means.

In attempting to appraise the world-wide situation and potential of secondary recovery, we face, in principle, a double hurdle. For any field or reservoir alone there is

usually a sufficiently hard problem in forecasting the productions obtainable by most appropriate primary and secondary methods. The assessment of the difference, in some individual cases, can, at the present time, be little better than inspired guess work, even when basic data on the reservoir and its past performance are available. To this must be added for the world as a whole the problem of the relative scarceness of data for any analyst, and, indeed, also doubt as to how to interpret much of what is published.

It is obviously not yet possible to build up a world picture with any pretentions to accuracy. What will be done here is to consider briefly first of all the U.S.A., which in many ways serves as an example, then to review some salient features of the rest of the world, and finally to make a broad brush extrapolation for the whole.

We need to bear in mind throughout that, in order to be regarded as acceptable, all secondary recovery projects have to be in one way or another economically attractive. They may be commercially viable purely on their own merits. Alternatively, they may also have attraction as conservation schemes, either by reason of proration regulations or in conjunction with considerations regarding other production. In either case they must, directly or indirectly, be competitive with other sources of oil, or with other fuels. On the world scale there is at the present time little place for high cost oil. Even now, facing the difficulties of over-availability and high taxation, secondary recovery is playing an important and growing role. We may be certain that if, in due time, the net prices of oil to producers rise, this will be adequately reflected by significant increases in the secondary recovery reserves.

**Secondary Recovery in the U.S.A.**

In the U.S.A. the first recorded intentional application of secondary recovery was in 1891, when a certain Mr Dinsmoor, in Pennsylvania, permitted intercommunication between a gas sand and an oil sand. Production of oil in nearby wells more than doubled. Air injection operations in Ohio came along 20 years later. By around 1916 there was intensive repressuring by air and gas injection in Hamilton Corners, Pennsylvania.

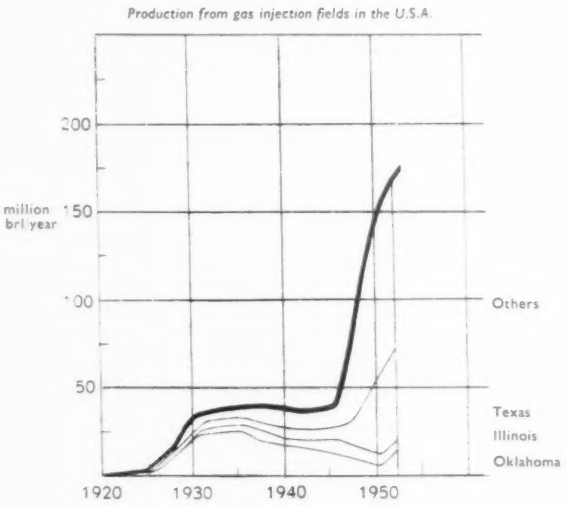



*Fig* 2

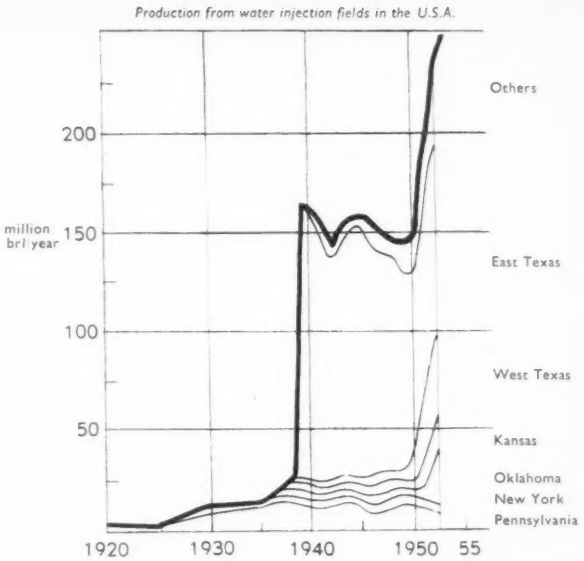



*Fig* 3

Effects of artificial water flooding were noted in 1907 in Bradford Field, Pennsylvania, and about five years later in near-by oilfields of New York State. Details are lacking, because introduction of water into oil sands was generally prohibited by law. It was only, however, by the 1920's that secondary recovery reached a noticeable scale; but growth since then has been remarkable. In 1925 the production from injection projects in the U.S.A. was some 20,000 bd. By 1935 it had reached 140,000 bd. In 1945 it was 530,000 bd, and by 1955 some 1,250,000 bd. One or two highlights in this period may be noted. In 1933 there took place the first complete unitization for secondary recovery by gas injection in Listerville Field, West Virginia. In 1939 water disposal was imposed for the East Texas field by court ruling to avoid pollution of the Angelina and Sabine rivers. In 1942, 23 per cent of the produced water was being returned and in 1952 over 98 per cent. Ultimate oil recovery efficiency may even be as high as 90 per cent from this field.

In 1948–1950 major gas injection schemes were initiated in the Texas Panhandle. High pressure (miscible) gas drives were started in Atlantic's University Block 31 and Humble's Pickton Field. The Atlantic project was by 1952 injecting 30 million cu ft day at high pressures. The Pickton Field was expected to have a primary recovery efficiency of 19 per cent, but, in consequence of secondary recovery, by 1958 some 41 per cent was being anticipated.

The large Salem pool, Illinois, was discovered in 1938. Full-scale water flooding was under way in 1953 with an injection rate of up to 180,000 bd of water. The anticipated ultimate oil recovery efficiency was raised by secondary recovery to some 70 per cent against 40 per cent by primary means.

The progress of secondary recovery in the U.S.A. up to 1953 is illustrated by the Figs 1, 2, and 3, which were published by A. E. Sweeney. They show the annual production from injection projects in the United States during the years 1920–1953. A striking rise over these years may be noted. The particularly steep rise in water injection just before 1940 was due to the East Texas Field.

An interesting feature is that injection projects appear first in the older and somewhat depleted fields, whilst as time progresses both gas and water injection are being applied more and more to the earlier phases of exploitation.

A longer view, to see where all this is going, is shown in Table I, which compares two sets of estimates for the U.S.A. that have been presented in recent years by Paul D. Torrey. From Torrey's various estimates there can be derived an approximate ratio between the total amount of oil estimated producible in the U.S.A. by known secondary methods, and the total amount producible by primary methods. Within the limitations of present economic considerations, Torrey's figures indicate that the ratio is apparently now about 1 : 5, and without such limitations it is apparently about 1 : 2.

TABLE I

| | *At* 1 *Jan.* 1954 | *At* 1 *Jan.* 1960 |
|---|---|---|
| | *million brl* | *million brl* |
| Oil originally in place ... ... | 272,000 | 328,000 |
| Cumulative production ... ... | 48,000 | 63,000 |
| Proven reserves (mainly primary) ... | 29,000 | 31,000 |
| Secondary recovery oil under current economic conditions ... ... | 11,000 | 15,000 |
| Maximum secondary recovery oil by known methods ... ... ... | 29,000 | 44,000 |
| Proven ultimate recovery efficiency | 28 per cent | 29 per cent |

One or two questions arise. In what way will economic circumstances change? In what way will technical developments put a kink in the forecasts? And in what degree may the estimates be useful in assessing the world picture?

The next three figures, after Roberts and Walker, summarize the reserves production picture for the U.S.A., and show their forecast of U.S. trends to the end of the century.

Of Fig 4, two features may be specially noted. The first is the very modest relation between the secondary recovery production to date plus the present secondary reserves, on the one hand, and the total proven ultimate production, as now assessed, on the other hand. The second feature is that Roberts and Walker visualize that by the year 2000, secondary recovery in the U.S.A. will be responsible for 100,000 million brl of production and reserves, in comparison with 150,000 million brl of primary oil. This ratio of secondary to primary oil of 100 : 150, or 2 : 3, is, of course, higher than Torrey's 1 : 5 ratio on account of their expectations of improvements in techniques, economic circumstances, etc., and is apparently more comparable to his 1 : 2 ratio.

On Fig 5 is given Roberts' and Walker's forecast that for the U.S.A. the average primary recovery efficiency for the composite of all commercially producible reservoirs may reach a maximum of 35 per cent; the improvement from the current level to the maximum is only modest. However, as regards future improvements in secondary recovery they are, relatively speaking, optimistic, visualizing that ultimately approximately 60 per cent of the oil discovered in the U.S.A. can be recovered by a combination of primary and secondary methods. Fig 6 summarizes Roberts' and Walker's estimates in the form of production-time curves.

An illustration of what happened in a state where crude is no longer in adequate supply is shown on Fig 7, which presents the growth of water-flood projects in California, as prepared by N. van Wingen and B. L. Melkonion. The steep rise in water-flood projects after 1951, when demand exceeded production, is notable. In the long run such a picture may become more common in other parts of the world.

Secondary recovery in the U.S.A. is clearly still gathering momentum. Not only are the successes being imitated, but projects are being initiated in the less obvious and more problematic cases. In large degree, this is due to the growth of know-how, and, in particular, to the strides made in reservoir and production engineering.

**Secondary Recovery Outside the U.S.A.**

Turning now to Canada, we find many similarities with the U.S.A. The long-term prospects, suitably scaled, are comparable, and in the overall long-term view they may perhaps be so considered. However, for the time being the over-availability of crude makes a difference. The Pembina Field, where 4000 million brl were originally in place, shows an interesting example. The forecast primary recovery efficiency was only 12½ per cent, due to a combination of low permeability, low solution GOR, and solution gas drive. Secondary recovery by water flood was already started in 1956, only three years after discovery of the field. Extensive engineering studies and pilot tests indicate by these means a potential increase in oil recovery efficiency to, say, 25–31 per cent, corresponding to 600 million brl of secondary recovery oil. More, apparently, could be obtained by

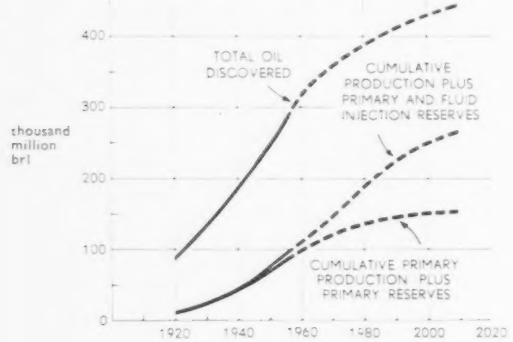



*Fig* 4

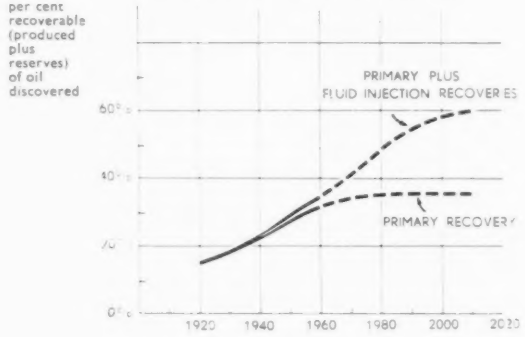



*Fig* 5

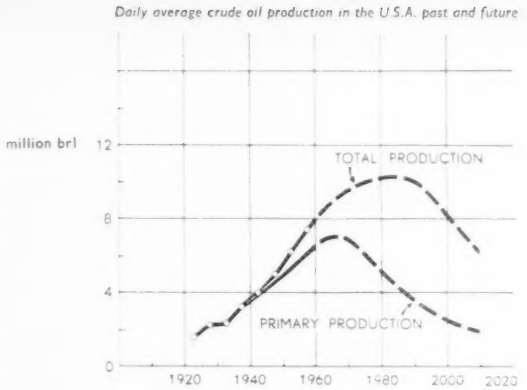



*Fig* 6

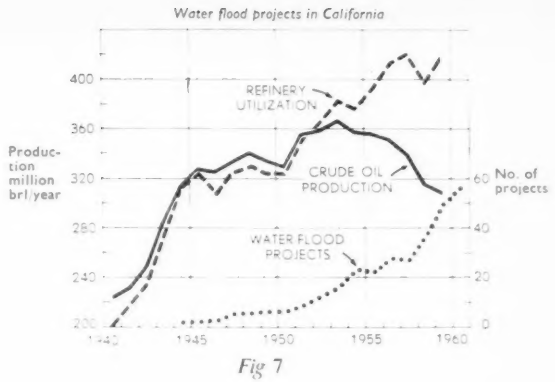



*Fig* 7

miscible drive, selectively injecting the heavier gas fractions. Pilot testing reportedly indicated a cumulative recovery in excess of 72 per cent of the effective oil in place from the producers in the pilot area. On the basis of this pilot test a large-scale miscible drive project was proposed. The interpretations of the pilot indicated a possible ultimate recovery for the large-scale project of some 50 per cent. However, for various reasons, and in particular a reduction of well allowables by the Alberta Board, the proponents substituted water flooding for miscible drive in three field units. Subsequently, the well allowable was raised and the originally proposed miscible drive project is apparently being reconsidered.

Outside of North America, in areas with little immediate use for the gas produced along with the oil, the gas conservation angle may be of great importance. This is particularly so in Venezuela, where already by 1960, in the country as a whole, around 1000 million cu ft day was being injected into oil reservoirs. It is very probable that this rate will increase appreciably in coming years. Of course, besides the advantage of gas conservation, and increased recovery from the reservoirs concerned, pressure maintenance by gas injection tends to keep up well potentials, and to reduce lifting costs and investments in wells.

In Venezuela, secondary recovery activity on a commercial basis began in the east, where there are many small, highly permeable, light-oil reservoirs. A number of small gas injection projects started in the period 1945–50. These were followed up in the same areas by an increasing number of such schemes, and also by many water floods. Results, generally speaking, are good.

Some 450 million cu ft day of gas in total are currently being injected into a considerable number of reservoirs in Eastern Venezuela. Published figures for one or two specific cases mention recovery increases due to gas injection of, say, 12 per cent of the oil in place, and, say, 14 per cent due to water flooding.

In Western Venezuela, major gas injection projects were started in Lake Maracaibo in 1954, 1959, and 1960. Total completed injection capacity is over 500 million cu ft day. In addition, Shell will very shortly be initiating a plant in one of the newer areas in the Lake with a gross capacity of 200 million cu ft day to inject, say, 120 millions.

Plans have recently been announced by Creole for a 300,000 bd water flood in combination with updip gas injection of 100 million cu ft day. Other projects are under study by various companies. Published data on the Creole LL 370 and LL 453 areas indicate anticipated recovery increases due to gas injection also of about 12 per cent of the oil in place.

The next area where secondary recovery operations on a large scale are under way is the Middle East. It is significant that the major Middle East reservoirs, with their offtake rates which are modest relative to reserves, apparently tend to be less sensitive to viscosity differences between gas and oil. Furthermore, as also applies to some extent in some other parts of the world, as Venezuela, etc., the extensive concessions minimize problems due to multiple ownership.

The first full-scale pressure maintenance operation in this area by gas injection started in 1938 in Bahrain. Gas from a deeper high pressure gas reservoir has been injected into the crest of a highly undersaturated oil reservoir, and is reportedly very successful. A further 10–20 per cent of oil in place may be obtained above the anticipated primary recovery by this gas injection project.

Complete pressure maintenance is under way in Aramco's Abqaiq field in Saudi Arabia, where gas injection started into the southern dome in 1954 and currently some 200 million cu ft day is being injected. Water injection into the northern area started in 1957 (240,000 bd). Recovery expectations are uncertain, but in the gas swept part recovery is reportedly being increased from 35 per cent primary to 54 per cent under gas injection. In the more recently developed water-drive area, various recovery efficiencies are quoted up to a maximum of 70 per cent.

Aramco is actively continuing its programme in the northern part of the big Ghawar field. A gas injection plant capable of injecting 200 million cu ft day into the Ain Dar area is already in operation. Furthermore, a gas plant to yield some 40,000 bd of raw LPG is under construction. The raw LPG is to be mixed with dry injection gas, and injected into the northern dome of Ain Dar, making it the largest enriched gas drive in the world (starting date 1 June 1961).

Pressure maintenance is also under way in Kirkuk. The decline of reservoir pressure, and low gas-oil ratios led to a start of pressure maintenance in 1957 by gas injection, up to approximately 200 million cu ft day. This is being succeeded by water injection, at rates up to 1 million bd, which will be one of the biggest water floods in the world. Besides the usual advantages of water injection, it is noteworthy that the presence of seepages means that gas injection

Progress of water flooding in the U.S.S.R.

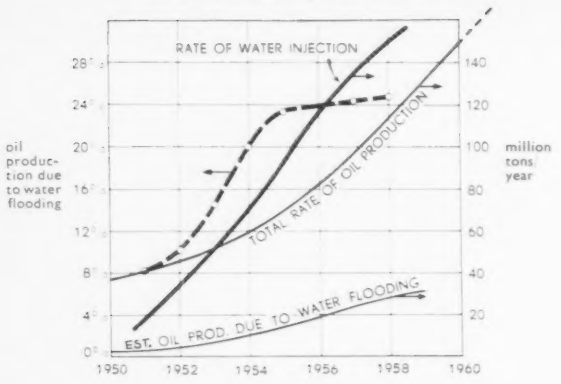



*Fig* 8

cannot be continued beyond a certain extent. In Kuwait, gas injection is now starting in the Burgan field at a rate of about 100 million cu ft day.

On the whole, the Middle East is becoming an active area for secondary recovery operations and, because of its large share of the total world crude oil reserves, also a very important one.

In the U.S.S.R. general conditions are distinct from those elsewhere. It is not surprising that oil exploitation methods also differ. The outstanding features, in the context of the present subject, are the very considerable growth in the scale of water flooding, and the frequency with which water injection is started early in the productive life of fields. Gas injection is seldom employed, being regarded as a less efficient technique under Russian conditions.

An idea of the extent of application of water injection, and its effect, is provided by Fig 8, which is based on data given by Krylov and others. The total rate of oil production has gone up from something of the order of 40 million ton year in 1950 to about 164 million ton year in 1961. The oil production estimated as due to water flooding has also gone up very markedly. This is shown as the lower section of the graph. The rate of water injection, from being something of the order of one-third of the rate of oil production in 1950–51, has increased so much that in recent years considerably more water, on a weight basis, is being injected in Soviet areas than oil is being produced. The percentage of oil production apparently due to water flooding may now be levelling off, seemingly somewhere around a quarter of the total. Already in 1957, oilfields operated under water injection yielded some 68 per cent of the total U.S.S.R. production. By 1960 this share had apparently risen to over 80 per cent.*

Various systems of flooding are employed: peripheral, or contour; pattern; and centre-to-edge; and they may be adjusted as flooding progresses. The patterns may be rather large, as, for example, in the very extensive Romashkino field. The centre-to-edge method in Novo-Dmitrovsky, or Ozek Soaat may be compared with say Sacroc in the U.S.A.

Besides the aim of increasing reserves, a significant reason given for the extensive use of pressure maintenance by water injection is the need to achieve fast build-up of oil potentials by keeping individual well productivities as high as possible. In 1948 some 29 per cent of the total production was obtained by flowing. By 1957 this had risen to over 70 per cent.

There is little published information on the overall recovery efficiencies being achieved in Russia. Krylov does indicate, however, that, after taking all possible measures where worth-while in water flooding, the ultimate recoveries in individual cases may lie in the range 50 to 90 per cent. The impression is gained that, as elsewhere, the higher figures are infrequent.

**Future Growth of Secondary Recovery**

In order to obtain an idea of the possible future growth of secondary recovery in the world, a summary of current overall trends in the major areas may be considered.

The United States figures for the total production rates from fields under secondary recovery are fairly conveniently available (Fig 1). In 1930 the production was 40 million brl from the injection projects, with a cumulative to that year estimated at 100 million brl. By 1945 annual production was approximately 200 million brl, with a cumulative of some 1800 million brl. By 1960 annual production is estimated (Fig 1) to be of the order of 530 million brl, with a cumulative of 7500 million brl. It is further estimated that some 30 per cent of these cumulatives may represent the extra secondary recovery oil. The future economically recoverable oil, due to known secondary recovery techniques, has also been estimated for the United States by Torrey, at the beginning of 1954, as about 11,000 million brl, and at the beginning of 1960 as 15,000 million brl. Something like half of these figures may represent oil attributable to projects already active, as may be seen from a project-by-project analysis for a representative sample. A very approximate summary of the trend over recent decades of ultimate secondary recovery oil due to active projects at various dates * may be derived. The results of such an assessment for the years 1945–1960 are shown in Fig 9, the lower line presenting the figures for the United States.

Figures for the U.S.S.R., obviously very tentative, may be

*According to recent references, during 1960 in nearly 70 per cent of the producing oilfields pressure was maintained by artificial means. Further, by 1965 some 81 per cent of the national crude output is expected to be derived from reservoirs under pressure maintenance.

* i.e., cumulative secondary recovery oil to date; plus reserve of secondary recovery oil, at that date, due to active and firm projects (U.S.A. 1960—approx. $0{\cdot}3 \times 7500 + 0{\cdot}5 \times 15000$ million brl).

Estimated world totals of recoverable oil due to active secondary recovery projects (very approx.)

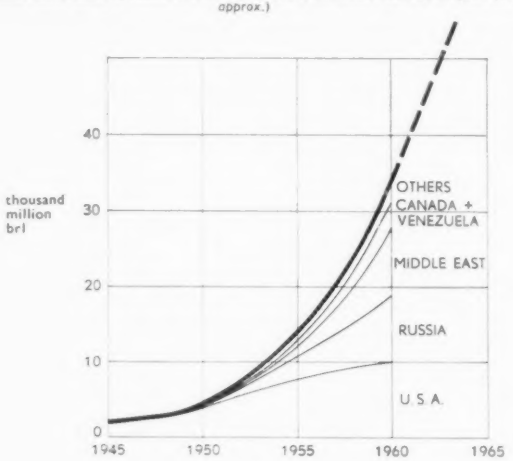



*Fig* 9

obtained from an overall assessment of data such as given on the graph of Fig 8, relative to activity in water flooding. At the end of 1951, the total extra ultimate recovery directly due to secondary recovery projects may be "guesstimated" as 500 million brl, but by the end of 1960, to have risen to something of the order of 9000 million brl. These results are plotted in Fig 10 on top of the line for the United States.

*Contribution of secondary recovery to world crude reserves in relation to overall totals*

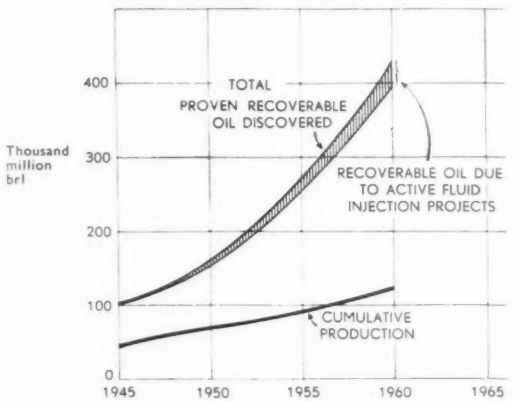



*Fig* 10

The estimates for the Middle East in Fig 9 are derived by means of an approximate project-by-project assessment. It may be noted that already by 1960 the total for the Middle East, due to active secondary recovery projects and those under construction, is approaching the same order of size as the respective totals for the U.S.A. or the U.S.S.R.

The Canadian figures are similarly derived from an individual project-by-project analysis. In 1950 the figure is nil; by 1960 it has risen to about 500 million brl.

The estimates for Venezuela are built up in part by project-by-project analysis, and in part by approximate overall relations. For the country as a whole, the estimated total extra ultimate production due to secondary recovery from active projects and those under construction, was by 1950 80 million barrels, by 1955 500 millions, and by 1960 some 2000 million brl.

The totals for Canada and Venezuela are for convenience of clarity included together in Fig 9, on top of the totals already obtained for the United States, the U.S.S.R., and the Middle East. Finally, in order to complete the graph, additional amounts have been provided for the other areas, not mentioned here in detail.

The ultimate recoverable reserves of oil in the world as a whole due to secondary recovery projects either active or under construction in 1950 were thus apparently of the order of 5000 million brl. By 1960 the figure had almost reached 35 thousand million brl. To put this into some perspective, we may note that the latter figure corresponds to say 8 per cent of the estimated total proven recoverable oil discovered by 1960. Fig 10 shows graphically and very approximately the relation between these estimates of secondary recovery oil and the overall proven totals.

What of the future? Information such as summarized on Fig 9 can leave little doubt that the contribution from secondary recovery will increase rapidly. This is shown in another form in Fig 11, in which the above estimates have all been incorporated. The oil reserves attributed to active and firm secondary recovery projects, at several dates, are plotted as percentages of the proven total ultimate recoveries at the same dates. As mentioned before, the world as a whole shows 8 per cent in 1960.

Again, obviously the overall trend is upwards. Obviously also extrapolation is difficult. We may perhaps hazard a guess that in the next decade or two the world average may rise to some 20 per cent of the total recovery. This would mean that for known accumulations alone something of the general order of 80,000 million brl might be recoverable by secondary recovery projects now under way or to be initiated in the next decade or two. The greater part of this, it would appear, would be additional to the 430,000 million brl currently carried as the total proven ultimate recovery.

As regards the long-term future, the scale of secondary recovery is very uncertain when considering all the unknowns such as the magnitude of new discoveries on which secondary recovery will be applicable, the possible improvements of conventional methods, the efficacy of novel methods possibly foreseen for the future, the economic climate, etc. Assuming, however, for the sake of this forecast, no dramatic changes in world conditions, we might proceed as outlined below.

Experience has indicated that under United States conditions, the average primary recovery efficiency, for commercial fields, may eventually be pushed up to say 35 per cent. As a first approximation, after due consideration of all features, we might take a similar or slightly lower figure for the world as a whole. To this we could tentatively add an allowance for secondary recovery, such as Fig 11 indicates might be reached in say the next couple of decades. The result would be an average recovery efficiency of something like 40–45 per cent, which is probably on the low side as an ultimate figure.

On the other hand, we might start from rather basic considerations, including points such as maximum displacement efficiencies of various processes, probable sweep efficiencies under practical conditions, energy needs for projects, economic limits, etc. The assessment would then be comparable to that of Roberts and Walker, who have given as their expectation that ultimately about 60 per cent of the oil discovered in the U.S.A. can be recovered.

For the world as a whole it would seem not unreasonable to consider such a figure would tend to be on the high side. It may possibly be agreed that general considerations point to weighty difficulties in raising the world average ultimate recovery efficiency much beyond something like 50 per cent. However, we can at least agree that the trend in recovery efficiency is strongly upwards, and that this, in the main, is now due to secondary recovery.

*Estimated percentages of ultimately recoverable oil attributed to secondary recovery at various dates*

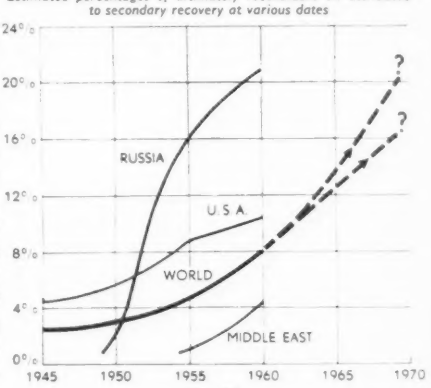



*Fig* 11

R. H. W. Hamilton commented that, with the very large recoverable reserves obtainable by so-called primary methods, there would seem little reason to an outside observer to embark on more expensive secondary recovery methods. The answer was, of course, that the latter was primarily a conservation measure. The fact that primary recovery methods gave relatively low percentage recovery of the oil in place was something which had always been a weak factor in the oil industry, and if this could be improved by something in the region of 50–60 per cent it would be an immense advantage in the future.

Regarding the Kirkuk water injection scheme, Mr Hamilton confirmed that approximately 1 million brl of water were already being injected into the reservoir every day. The gas injection scheme had been used at Kirkuk purely as a temporary measure to hold the reservoir pressure to acceptable levels until the water injection plant could be completed. It would, however, take a very long time to find out how successful the scheme was going to be.

When the question of the relative costs of obtaining incremental oil from secondary recovery versus the obtaining of additional oil through exploration was posed, Mr Stephenson pointed out that both estimates were extremely difficult to make, and data on individual examples were difficult to come by and might not be representative of the whole picture. As regards the growth of secondary recovery reserves compared with the growth of what might be called primary recovery reserves, he felt, with other forecasters from the U.S.A., that prospects were that the secondary recovery oil growth would become somewhat faster in relation to the primary recovery oil. In the world as a whole, he agreed there was certainly plenty of opportunity for the exploration geologist. Exploration was still important.

A further question was that in the past the assumption has always been, in a strong water-drive reservoir, that the aim should be to keep the reservoir above the saturation pressure. Had the speaker had any experience of attempts made to take a water-drive reservoir below its saturation pressure, because relative permeability data, 3-phase permeability data, could sometimes indicate that a higher recovery could be obtained on water flood, following gas injection? Maybe one could see the same effect by taking the reservoir below its saturation pressure first, to get a gas saturation, followed by water flooding.

Mr Stephenson replied that that was still an open question. Some experts had said that the recovery efficiency was not apparently harmed by having the pressure fall somewhat below the bubble point. The problem was still being debated and it would vary from case to case.

Mr Stephenson agreed that the volume of water injection in the Russian water floods was apparently something of the order of five times as great as the volume of oil recovered thereby, and that this ratio seemed high.

It was particularly noted that it was estimated that the primary recovery peak for the U.S.A. was 1965 before the production would fall off: whereas the secondary peak was not until 1980.

Questioned whether there was any theoretical or practical evidence that perhaps we could learn from the Russians in secondary recovery techniques, and were we rather slow in picking up secondary recovery from the point of view of efficiency and ultimate production, Mr Stephenson thought that one had to consider very carefully in reviewing the possibilities of any process, and not only how it might work under any particular set of circumstances, but also different circumstances including different dates of initiation. There might well be conditions in which the initiation of the project could be the best at the earliest possible moment. Invariably, however, one found that the data available in the early stages were completely inadequate for proper engineering of projects, and it was often found subsequently that the naturally available forces were different from what had been originally thought.

# Around the Branches

ABADAN, BAHRAIN, ESSEX, FAWLEY, KUWAIT, LONDON, NORTHERN, SCOTTISH, SOUTH-EASTERN, SOUTH WALES, STANLOW, TRINIDAD, YORKSHIRE

### Yorkshire Branch

A party of some thirty members made an evening visit to the Melbourne Brewery in Leeds on 14 September, although one or two persons were heard to say on leaving "they didn't know what day it was"!

The party was given a very frank and informative tour, and this raised questions on topics ranging from hops to yeast. It was interesting to note that while coopering in the oil industry vanished many years ago, it is still active here, and it appears that Russian or German oak is used because of its hardness. After the tour the party staggered to the Step Inn, which lies within the brewery, and was lavishly entertained to the Company's best brews free of charge, and to many it seemed that Utopia had come at last. When regretfully it was "time" members had the pleasure of leaving with a mild or bitter taste in their mouths. One member's pertinent comment afterwards was "Dare we look forward to a visit to a distillery one day?"

### Bahrain Branch

"Factories should be places fit for people to live in". With this quotation of a former H.M. Chief Inspector of Factories, D. H. Brown, safety adviser to the Bahrain Petroleum Co, summed up the compelling need that had led to the Factories Acts and the multiplicity of rules and regulations made by Parliament.

Mr Brown, who was introduced by the chairman, D. G. Johnstone, was speaking to the Bahrain Branch on 7 August, and he began by reviewing the development of Factory Act legislation in Britain from the 1802 Act that required "pauper apprentices" to read their Bibles but did little for their safety: through the period when inspectors were both prosecutor and judge, trying, convicting, and imposing fines on the spot: to the modern specialist inspectors now firmly established as the friends of industry.

Mr Brown's programme included a tape recording which took his audience along with him on a factory inspection visit. With appropriate background noises the audience heard his conversation with the factory manager as they discussed various applications of the Acts.

In the latter part of his talk Mr. Brown considered the dangers that impinge on the individual when he enters the industrial environment. Foreseeable and unforeseeable dangers "in law" and the Du Parcq dictum on danger were also discussed.

# Automotive Trends in a Changing Market

*The following is a summary of a paper presented recently by Victor G. Raviolo of the Ford Motor Company to a session on automotive research during the 26th Mid-year Meeting of the American Petroleum Institute's Division of Refining in Houston, Texas*

Mr Raviolo began by reviewing some of the factors which had influenced American manufacturers. Among them were a rapid growth of suburban areas, the increase in multiple-car households, and the decline in the use of public transport. Another factor in the calculation of future requirements was said to be the national economic pattern. In the United States, the gross national product was expected to advance at least as fast in the next decade as in the last one.

Mr Raviolo went on to say that the great growth opportunities to-day were outside the United States. By 1965, he expected that overseas manufacturers would produce as many automobiles as were currently produced in the U.S.

These foreign and domestic factors, had led to a sweeping revision in marketing and engineering patterns in the U.S.

**Future Engine Developments**

A new series of engines was coming, probably in the mid-1960's, which would be the result of the research of the last decade. Discussing some possible trends, he said that flat engines were especially favourable for rear-engine installations, but not as adaptable to the front because of the lesser width available between the steering wheels. Front engine packages were adaptable to the smallest size of car. However, the package concept was difficult to apply to the larger cars because of the greater ratio of power-plant weight to total weight. The larger cars, he thought, might well continue to use the conventional driveline for some time.

He forecast that fuel prices would rise as the world demand for fuel increased, and that rising prices would be reflected in smaller average vehicle size and lower average horsepower.

Discussing the search for new energy sources, Mr Raviolo said that nuclear energy would probably not be applicable directly to ground vehicles, but it might be a secondary source. The fuel cell, he said, was intriguing, despite its present cost, weight, and size. The promise of efficiency of 85 per cent or better was exciting when compared to the reciprocating engine.

Turning to the more conventional power plants, Mr Raviolo said that there were three types that included turbines in the final drive that showed promise in specific automotive applications—the gas turbine, the free-piston gasifier plus turbine, and the compound engine.

The gas turbine promises very high power-to-weight ratio and the ability to burn lower-cost fuels. Fords, he said, were making progress with a new arrangement said to consist of a low-speed, low pressure turbo-compressor allied with a high-speed, high-pressure turbo-compressor. The fuel consumption was said to be within the diesel range at all speeds and loads, and to have a flat curve.

A solution to materials and production techniques was well under way, said Mr Raviolo. The Ford Scientific Laboratory had successfully developed iron-aluminium alloys which were ductile and could replace stainless steels for many applications. Such techniques as forging all the individual turbine blades into the hub in one blow had also been developed. Being competitive in first cost and in operating economy, the turbine's great advantage would lie in lower weight (a quarter of that of an equivalent diesel) and in greater life (two to three times that of a typical diesel). This engine was foreseen as a contender in the heavy-duty truck and bus field, but there was little promise that costs equal to automobile gasoline engine costs could be achieved.

Ford engineers had designed and developed a free-piston gasifier and turbine combination some time ago and had installed one in a tractor. It was a technical success, but was found not to offer enough advantages to create a new market demand. Cost studies determined that the engine could be produced at a cost slightly less than a tractor diesel but not as low as a gasoline engine. The prime limitation was the low frequency (corresponding to low revs/min in diesels) that resulted in low power-to-weight ratio. This in turn inhibited broad application to ground vehicles other than tractors and heavy-duty earth-moving equipment.

The compound engine was, the author said, theoretically the most-desirable and practically the least-desirable vehicle engine. The theoretical cycle indicated the highest efficiency, but in cost and complications the engine included the worst features of both piston and turbine engines.

Mr Raviolo said that he believed that conventional piston engines would continue to power most vehicles in the next decade, but that he also believed that some major developments, such as high-speed, light-weight diesels and stratified-charge engines would be forthcoming. Leading laboratories around the world, he said, were working on high-speed diesels, intended for maximum operating speeds of more than 4000 revs/min. The problems of injection and combustion had been resolved in the laboratory and would soon be reduced to production practice.

The conversion of a heavy-duty truck from gasoline to diesel power was very costly because of the lower maximum speed and greater weight of the diesel. Higher speed meant a higher power-to-weight ratio, but also meant that the same transmission axle and running gear could be used for gasoline or diesel. The cost of conversion could be reduced to about one-fourth of former costs.

There are also some interesting developments ahead for gasoline engines, said Mr Raviolo, which more properly will be classified as stratified-charge engines. These might use pre-combustion chambers supplied with stoichiometric mixture, which would be spark-ignited and, in turn, fire a lean mixture in the main chamber, or they might use a stratified charge in the main chamber by control of air and fuel flow. In any case, they almost certainly would use fuel injection, and might well run with an open throttle, except for very low speed and load. There must, he thought, be a means for separating the normal firing charge from the very lean mixture, that can be burned only with high-energy ignition. Such engines will probably run with excess air. Potential fuel economy was projected for certain of these arrangements at more than a 50 per cent improvement in miles/gal. Mr Raviolo did not, however, expect that the development of such engines could be brought along fast enough to be introduced in the mid-1960's.

# *Ownership of World Oil Production in 1960*

Figures issued recently by the Petroleum Information Bureau show that British and British-Dutch oil companies produced 16·9 per cent of the world's crude oil supplies in 1960. Their total output of 184,225,000 metric tons was the highest ever and some 12 million tons more than in 1959.

British and British-Dutch production was derived from twenty-five different countries, the largest individual sources being Venezuela, 45·1 million tons, and Kuwait, 40·9 million tons. On a regional basis, the Middle East contributed 52·8 per cent of the total, Latin America 28 per cent, and the Far East and Australasia, Africa, and Western Europe the remaining 19·2 per cent.

Algeria, which includes the French Sahara, made its first contribution to the British and British Dutch total in 1960 with a yield of 675,000 tons.

United States companies remained by far the largest world suppliers, their total production of 652,465,000 tons representing some 59·9 per cent of the world's total output of 1,089,580,000 tons. The Soviet Bloc was the third largest producing group with 167,000,000 million tons, which was equivalent to 15·3 per cent of the world total.

Table I, which includes a comparison with the year 1956, and Table II, which contains less detailed statistics for 1951, reflect the trend which has caused the U.S. companies share of world production to fall rather sharply. Since 1956 their proportion of the world total has dropped some 5·9 per cent, and compared with 1951 the drop has been even more dramatic, from 71·8 per cent to 59·9 per cent.

Over the same period, the British and British-Dutch interests have more than maintained their share of the world total. Despite a dip to 14·4 per cent in 1956, the 1961 figure of 16·9 per cent was 0·8 per cent in advance of that for 1951. It should be remembered, however, that oil operations in Persia were suspended for a large part of the latter year.

The reduction in the share of the U.S. companies is largely accounted for by the increased holdings being taken up by government interests in indigenous production. This was also one of the factors responsible for the growth from 12·1 per cent to 23·2 per cent of world production by countries classified as "others". The substantial increase in Soviet production also contributed to this trend.

Since 1951, world production has increased by 79·4 per cent. All areas contributed to this increase, but the most notable rises were achieved by the Middle East, the Soviet Bloc, and North America, where United States production rose by a modest 18 per cent and Canadian output climbed by over 325 per cent.

TABLE II

OWNERSHIP OF OIL PRODUCTION—1951

(Thousand metric tons—at year end)

| | *British and British Dutch* | *U.S.A.* | *Others* | *Total* |
|---|---|---|---|---|
| Western Europe | 470 | 580 | 1,570 | 2,620 |
| Middle East ... | 37,800 | 55,820 | 3,160 | 96,780 |
| North America... | 14,760 | 312,190 | 3,700 | 330,650 |
| Latin America ... | 35,170 | 66,100 | 15,640 | 116,910 |
| Far East ... | 9,940 | 3,530 | 570 | 14,040 |
| U.S.S.R. Bloc ... | — | — | 49,000 | 49,000 |
| TOTAL ... | 98,140 | 438,220 | 73,640 | 610,000 |
| Per cent of world total | 16·1 | 71·8 | 12·1 | — |

TABLE I

OWNERSHIP OF OIL PRODUCTION

(Thousand metric tons—at year end)

| *Country* | 1960 | | | | 1956 | | | |
|---|---|---|---|---|---|---|---|---|
| | *British and British Dutch* | *U.S.A.* | *Other* | *Total* | *British and British Dutch* | *U.S.A.* | *Other* | *Total* |
| WESTERN EUROPE | | | | | | | | |
| Western Germany ... ... ... | 210 | 1,100 | 4,250 | 5,560 | 120 | 520 | 2,880 | 3,520 |
| Austria ... ... ... ... ... | 105 | 105 | 2,230 | 2,440 | 50 | 50 | 3,330 | 3,430 |
| France ... ... ... ... ... | 50 | 1,200 | 1,010 | 2,260 | — | 1,020 | 270 | 1,290 |
| Netherlands ... ... ... ... | 945 | 945 | — | 1,890 | 545 | 545 | — | 1,090 |
| Italy (incl. Sicily) ... ... ... | — | 1,405 | 645 | 2,050 | — | 430 | 190 | 620 |
| Yugoslavia ... ... ... ... | — | — | 1,040 | 1,040 | — | — | 290 | 290 |
| United Kingdom ... ... ... | 90 | — | — | 90 | 60 | — | — | 60 |
| Total ... ... ... ... ... | 1,400 | 4,755 | 9,175 | 15,330 | 775 | 2,565 | 6,960 | 10,300 |
| MIDDLE EAST | | | | | | | | |
| Kuwait ... ... ... ... ... | 40,930 | 40,930 | — | 81,860 | 27,495 | 27,495 | — | 54,990 |
| Saudi Arabia ... ... ... ... | — | 60,860 | — | 60,860 | — | 48,710 | — | 48,710 |
| Persia ... ... ... ... ... | 27,970 | 20,720 | 3,370 | 52,060 | — | — | 26,510 | 26,510 |
| Iraq ... ... ... ... ... | 23,740 | 10,645 | 13,095 | 47,480 | 15,840 | 7,010 | 8,490 | 31,340 |

| Country | 1960 | | | | 1956 | | | |
|---|---|---|---|---|---|---|---|---|
| | *British and British/Dutch* | *U.S.A.* | *Other* | *Total* | *British and British/Dutch* | *U.S.A.* | *Other* | *Total* |
| Qatar | 3,900 | 1,950 | 2,360 | 8,210 | 2,790 | 1,400 | 1,690 | 5,880 |
| Neutral Zone | — | 7,270 | — | 7,270 | — | 1,670 | — | 1,670 |
| Egypt | 675 | 415 | 1,980 | 3,070 | 1,200 | 480 | — | 1,680 |
| Bahrain | — | 2,250 | — | 2,250 | — | 1,510 | — | 1,510 |
| Turkey | — | — | 350 | 350 | — | — | 320 | 320 |
| Israel | — | — | 130 | 130 | — | 5 | 15 | 20 |
| Total | 97,215 | 145,040 | 21,285 | 263,540 | 47,325 | 88,280 | 37,025 | 172,630 |
| **AFRICA** | | | | | | | | |
| Algeria (incl. Sahara) | 675 | — | 7,875 | 8,550 | — | — | 40 | 40 |
| Gabon | — | — | 860 | 860 | — | — | — | — |
| Nigeria | 880 | — | — | 880 | — | — | — | — |
| Morocco | — | — | 100 | 100 | — | — | 100 | 100 |
| Angola | — | — | 70 | 70 | — | — | — | — |
| Total | 1,555 | — | 8,905 | 10,460 | — | — | 140 | 104 |
| **NORTH AMERICA** | | | | | | | | |
| U.S.A. | 19,225 | 363,035 | 860 | 383,120 | 18,070 | 363,790 | 1,270 | 383,130 |
| Canada | 1,405 | 13,700 | 12,295 | 27,400 | 690 | 13,910 | 9,050 | 23,650 |
| Total | 20,630 | 376,735 | 13,155 | 410,520 | 18,760 | 377,700 | 10,320 | 406,780 |
| **LATIN AMERICA** | | | | | | | | |
| Venezuela | 45,145 | 103,595 | — | 148,740 | 39,110 | 89,990 | — | 129,100 |
| Mexico | — | — | 15,350 | 15,350 | — | — | 13,230 | 13,230 |
| Colombia | 2,025 | 4,425 | 1,600 | 8,050 | 2,180 | 2,570 | 1,620 | 6,370 |
| Argentina | 370 | 20 | 8,770 | 9,160 | 440 | 40 | 3,940 | 4,420 |
| Trinidad | 3,155 | 2,865 | — | 6,020 | 3,410 | 770 | — | 4,180 |
| Brazil | — | — | 4,050 | 4,050 | — | — | 530 | 530 |
| Peru | 520 | 1,960 | 150 | 2,630 | 740 | 1,670 | 120 | 2,530 |
| Chile | — | — | 990 | 990 | — | — | 500 | 500 |
| Bolivia | — | — | 390 | 390 | — | — | 440 | 440 |
| Ecuador | 340 | 50 | — | 390 | 350 | 50 | 90 | 490 |
| Cuba | — | — | 30 | 30 | — | — | 80 | 80 |
| Total | 51,555 | 112,915 | 31,330 | 195,800 | 46,230 | 95,090 | 20,550 | 161,870 |
| **FAR EAST AND AUSTRALASIA** | | | | | | | | |
| Indonesia | 5,800 | 12,920 | 1,480 | 20,200 | 5,250 | 7,460 | — | 12,710 |
| British Borneo | 4,690 | — | — | 4,690 | 5,800 | — | — | 5,800 |
| Burma | 480 | — | 50 | 530 | 240 | — | — | 240 |
| India | 440 | — | — | 440 | 390 | — | — | 390 |
| Japan | — | — | 510 | 510 | — | — | 300 | 300 |
| Pakistan | 360 | — | — | 360 | 300 | — | — | 300 |
| New Guinea | 100 | 100 | — | 200 | 150 | 220 | — | 370 |
| Total | 11,870 | 13,020 | 2,040 | 26,930 | 12,130 | 7,680 | 300 | 20,110 |
| **U.S.S.R. BLOC** | | | | | | | | |
| U.S.S.R. | — | — | 148,000 | 148,000 | | | | |
| Rumania | — | — | 11,500 | 11,500 | | | | |
| *China | — | — | 5,200 | 5,200 | | | | |
| Hungary | — | — | 1,200 | 1,200 | | | | |
| Albania | — | — | 600 | 600 | — | — | 97,100 | 97,100 |
| Bulgaria | — | — | 190 | 190 | | | | |
| Poland | — | — | 200 | 200 | | | | |
| Czechoslovakia | — | — | 110 | 110 | | | | |
| Total | — | — | 167,000 | 167,000 | — | — | 97,100 | 97,100 |
| Per cent of world total | 16·9 | 59·9 | 23·2 | | 14·4 | 65·8 | 19·8 | |
| **WORLD TOTAL** | 184,225 | 652,465 | 252,890 | 1,089,580 | 125,220 | 571,315 | 172,395 | 868,930 |
| 1959 | 172,528 | 622,941 | 216,664 | 1,012,133 | | | | |

* Including crude oil from shale and coal.

# Personal Notes

*H. C. Tett* *C. S. Windebank* *Dr N. V. Hakala*

**C. S. Windebank,** B.Sc., M.S., A.M.I.Chem.E., F.Inst.Pet., who was previously chairman and managing director of Esso Research Ltd, is now vice-chairman of the "New Petroleum Uses Committee" of the Standard Oil Company (New Jersey) in New York. Mr Windebank remains a director of Esso Research but has relinquished other offices.

**H. C. Tett,** B.Sc., D.I.C., A.R.C.S., A.M.I.Mech.E., F.Inst.Pet., chairman and managing director of Esso Petroleum Co. Ltd, has been elected chairman of Esso Research Ltd, of which he was already a director, in succession to Mr Windebank.

**Dr Neil V. Hakala** has been appointed to the Board of Esso Research Ltd, and elected managing director. Dr Hakala, who joined Esso Research and Engineering Co of Linden, New Jersey in 1943, was serving as deputy to the vice-president responsible for analytical, basic, medical, and petroleum product research at the time of his new appointment. In his new post, he will be based at the Research Centre at Abingdon, Berks.

**H. D. Galloway** was recently elected chairman of A/S Esso Raffineriet Norge. Mr Galloway had earlier been elected a member of the board at the Company's annual general meeting, and, in addition to his new post, will continue as director and vice-chairman of A/S Norske Esso.

Mr Galloway has held a variety of marketing and executive positions during his 29 years with Jersey Standard companies, and has served in the United States, England, Puerto Rico, Brazil, and Norway.

*G. A. Malone*

**Gordon Alexander Malone,** A.M.I.Mech. E., general manager of BP Refinery (Aden) Ltd, died whilst on leave from Aden recently. Mr Malone joined BP in 1936, and served in Persia where, with the exception of the war years, he remained until 1952. He was then appointed superintendent of the Public Works Department in Aden. In 1955 he became chief engineer at the refinery, a post which he held until 1958, when he was appointed general manager.

Whilst in Aden, Mr Malone was elected chairman of the Aden Joint Group Engineering Society of the Civil, Mechanical, and Electrical Institutions.

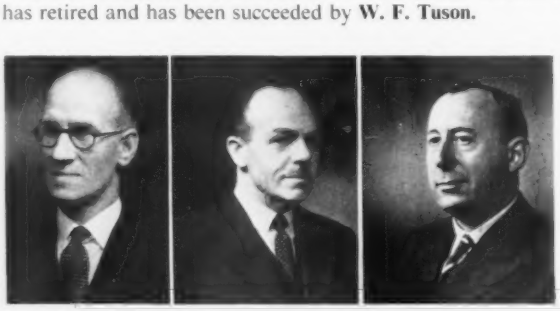
**P. H. Bohart,** administrative vice-president and co-ordinator of the Gulf Oil Corporation, has been appointed senior vice-president of the Company. Among the additional duties he will assume is the responsibility for the executive supervision of the Crude Oil Department.

Mr Bohart joined Gulf as a geologist in Texas in 1919, and has served in Mexico, Colombia, and Tulsa, Oklahoma. He transferred in 1956 from Tulsa, where he had been vice-president in charge of the Production Division, to Pittsburgh to head the Planning and Economics Department. He took up his post as administrative vice-president and co-ordinator in 1959.

Another Gulf appointment is that of **P. H. Clancy** who has become Co-ordinator of the Crude Oil Department.

**Lt. Commander C. R. Manasseh,** M.I.Mar.E., A.M.I. Mech.E., A.F.Inst.Pet., F.I.L.(Fr), has been appointed chief engineer of Snowdrift Lubricants Ltd.

**E. E. Bullen,** Shell Chemical Co. Ltd's finance director, has retired and has been succeeded by **W. F. Tuson.**



*W. F. Tuson* *A. J. Gait* *A. N. Holmes*

Mr Tuson will be known as director, finance and economics, and will be responsible for the Company's Economics and Planning Department, which is headed by **A. J. Gait.**

Mr Gait took over his new position from **A. N. Holmes,** who has become general manager of the Plastics and Rubbers Division in succession to **W. K. McGavin,** who as director of the Company has undertaken new responsibilities.

**F. Davies** and **P. W. Jacob** have become sales managers – rubbers for the North and South Regions of the Plastics and Rubbers Division of Shell Chemical Co. Ltd. Both Mr Davies and Mr Jacob have been concerned with the marketing of the Company's rubbers since they were introduced to the market in 1958.

Mr Davies is a committee member of the Manchester Section of the Institute of the Rubber Industry.

**A. C. Hamilton** has been elected treasurer of Esso International Inc. in succession to **R. B. Stokke** who will continue to serve as a director.

Mr Hamilton joined Jersey Standard treasurer's department in 1946 as a foreign exchange analyst. He transferred to Esso International Inc. in 1951. In 1954 he was appointed assistant treasurer of the Company and 2 years later he became treasurer of International Petroleum Company, Ltd, the position from which he has resigned to accept his new post.

*H. F. Barnes*

*J. T. Caddie*

**H. F. Barnes,** who has been appointed manager of the Rotherhithe (S.E. London) plant of Castrol Ltd, succeeds **W. E. Ryde** who has retired after 42 years service. Mr Barnes joined W. B. Dick & Co. Ltd in 1925, and was appointed manager of that Company's Liverpool plant in 1940, becoming assistant manager, Rotherhithe in 1950.

The new assistant manager at Rotherhithe is **J. T. Caddie** who joined W. B. Dick & Co. Ltd as a laboratory assistant at Glasgow in 1932, transferring to Rotherhithe in 1938.

**Peter B. Binsted** managing director of Gulf Oil Marine Agency at Antwerp, Belgium, has been named manager of transportation of Gulf Eastern Company in London. He succeeds **R. G. Martin**, who has retired. Mr Binsted, who was born in London, joined Gulf in 1957.

**W. C. Brodhead,** departmental co-ordinator of transportation in the Pittsburgh headquarters of Gulf Oil Corporation, has been named manager of the Marine Department in succession to the late **Carl F. Vander Clute.** Mr Brodhead has been with Gulf since 1926.

**F. Hugh Wilson** has become exploration manager of Tidewater Oil Company's Foreign Exploration and Production Division in succession to **Robert Dyk,** who recently resigned.

Mr Wilson, who joined Tidewater in 1940, was previously foreign exploration planning co-ordinator and, prior to that, Western Division exploration manager. A graduate of the Missouri School of Mines, he also attended Harvard University under Tidewater's executive development programme.

**George A. Lawrence,** member of the Public Relations Department of Imperial Oil Ltd, has been appointed deputy director of public relations for Standard Oil Co. (New Jersey).

**C. A. Harrison** has been appointed manager of Technical Services Department of Iranian Oil Services Ltd in place of L. E. Chatfield, who has returned to the U.S.A.

**Harry West,** M.Sc., M.I.Mech.E., M.I.E.E., managing director of A.E.I. (Manchester) Ltd, was installed as President of the Institute of Welding for 1961/62 at the recent annual general meeting. Two new Vice-Presidents who also took office at the same time are **C. Humphrey Davy,** M.I.Mech.E., director of Babcock and Wilcox Ltd, and **L. Redshaw,** M.Eng., M.R.I.N.A., deputy managing director of Vickers-Armstrongs (Shipbuilders) Ltd.

**Gordon B. Dunn,** A.F.Inst.Pet., who was formerly with the Anglo-Iranian Oil Company and has spent the past 7 years in the U.S.A., was elected vice-president of the National Expansion Joint Manufacturers Association at the Association's last annual meeting. Mr Dunn is manager sales engineering—industrial products of the Solar Aircraft Company in San Diego.

**A. H. Campbell,** M.A., M.I.E.E., who has been a director of Hilger & Watts Ltd since 1951 and general manager since 1954, has been appointed joint managing director with **G. A. Whipple,** M.A., M.I.E.E., F.Inst.Pet.

**W. N. Collins,** M.I. Mech. E., has resigned his directorships in F. Perkins Ltd and its subsidiaries, including his post as assistant managing director of the parent company. He is not, however, severing his connexion with the Group immediately, but will gradually relinquish his duties over the next few months. Mr Collins has played a major part in the Company's international marketing activities since the end of World War II.

**T. H. R. Perkins** has been appointed assistant managing director and will continue as marketing director of the Perkins Group. Mr Perkins joined F. Perkins Ltd in 1940, and has held office as export sales manager, director of overseas development, and general manager of the sales division. He joined the board of F. Perkins Ltd in 1951.

Three other new appointments also announced by the Perkins Group concern:

**D. F. W. McNair** who has been appointed deputy director of marketing of the Group; **J. M Collins,** a director of Perkins Engines Ltd, who has been appointed general manager of the Perkins Group's sales division, and **H. Lymath,** who joined the company a year ago to carry out special duties connected with parts and engine classification, who succeeds Mr McNair as group project co-ordinator.

**R. H. Dent,** deputy chairman and managing director of the Cape Asbestos Company Ltd, has been elected chairman of the company's subsidiary Cape Insulation and Asbestos Products Ltd. In addition, **A. T. Mendelle** has been appointed plant manager of the Company's factory at Barking, in succession to **A. A. Cross**

The Company's managing director, **A. G. Grant,** has been elected chairman of Andersons Insulation Company.

*R. K. Van Sickle*

**Richard K. van Sickle,** who owned the drilling enterprise in Vienna which bears his name, died recently in Baden. Mr van Sickle, who was the son of a British oil expert, was born in Rumania and educated in England. In 1935 he acquired a number of Austrian drilling rights in Neusiedl a.Z., where he was the first successful prospector.

He spent the war years with the British Army, seeing service in Africa and achieving the rank of Colonel. He returned to the Austrian oilfields in 1945 where he founded the present firm.

Mr van Sickle had been a Fellow of the Institute since 1927.

*R. Morrison*

**R. Morrison** and **A. H. Simpson** have been appointed to the board of directors of Woodfield Rochester Ltd. Mr Morrison is secretary of the company and Mr Simpson is general sales manager, positions they will continue to hold.

Following a recent illness, **D. R. Mackie** has resigned from his position as managing director of Monsanto Chemicals Ltd, but will continue as a member of the board. Mr Mackie will be succeeded as managing director by **John C. Garrels**, Jnr., deputy managing director, who has been actively carrying out the duties of managing director since Mr Mackie's illness in March. Mr Garrels joined Monsanto Chemicals Ltd from the Plastics Division of its American parent company at the beginning of 1961.

**D. F. Campbell** is retiring from the chairmanship of Davy-Ashmore Ltd in September. He will be succeeded by **M. A. Fiennes**, who is group managing director of the Company, a position he will continue to hold. Mr Fiennes is also retaining his post as chairman of Davy and United Engineering Co. Ltd, but will be succeeded as managing director of that company by **M. F. Dowding.**

Major **W. R. Brown**, who joined the board of Davy-Ashmore Ltd when it was merged with the Power Gas Corporation in 1960, is also retiring, but will remain a director of Ashmore, Benson, Pease & Co. Ltd.

**R. Lessing**, C.B.E., Ph.D., F.R.I.C., M.I. Chem. E., F. Inst. Pet., Hon. M. Inst. Gas., has been appointed deputy chairman of Hydronyl Ltd. He was formerly managing director, a position he had held since the formation of the Company in 1914.

**H. C. H. Matthews**, B.Sc., A.M.I.E.E., has been appointed a technical director of Pantak Ltd.

**C. A. Bell**, F.C.I.S., has been appointed secretary of Richard Costain Ltd in place of **J. B. Parrett**, A.A.C.C.A., who has become a director.

*E. J. Robinson*

*R. F. N. Otway*

**E. J. Robinson** has been appointed a director of The Head Wrightson Export Co. Ltd, and **R. F. N. Otway** has joined The Head Wrightson Export Co. Ltd, as manager—Europe. Before taking up this appointment Mr Otway was with The Morgan Crucible Co. Ltd.

**Dr A. R. Pinnington** has been appointed sales manager (development) of Fullers' Earth Union Ltd.

**A. W. Jones**, Fleming Radio (Developments) Ltd, was recently installed as President for 1961–2 of the Scientific Instrument Manufacturers' Association of Great Britain. **G. C. Ottway**, the retiring president, has become a vice-president of the Association.

**Henry Foxwell Sherborne**, M.C., managing director of Yorkshire Imperial Metals Ltd, has been appointed president of the British Non-Ferrous Metals Federation in succession to W. W. Dolton, managing director of the Delta Group of Companies.

**Miles N. Clair**, president of The Thompson & Lichtner Co. Inc, was elected president of the American Society for Testing Materials at its 64th Annual Meeting held in Atlantic City recently.

**Alfred C. Webber**, of E. I. duPont de Nemours and Co. Inc., was elected vice-president. **R. Wade Seniff**, of The Baltimore and Ohio Railroad Co., will continue as senior vice-president.

New members elected to the board of directors include **Bruce W. Gonser** of the Battelle Memorial Institute, **Gordon M. Kline** of the National Bureau of Standards, and **James B. Rather**, Jnr, co-ordinator in charge of toxicology and air and water pollution, Socony Mobil Oil Co. Inc.

**F. Winston Reynolds**, who founded Winston Electronics Ltd, has relinquished his duties as chairman and managing director of the Company.

**W. Allen Bridges**, who has replaced him as chairman and managing director, is also director of European operations of the Dynamics Corporation of America.

## REDUCED SUBSCRIPTIONS FOR RETIRED MEMBERS

The Council of the Institute has been giving some thought to the possibility of introducing a special scheme for retired members to continue their membership at a reduced annual subscription, provided they have been associated with the Institute for a considerable period of time and have retired from a full-time position in the industry.

A scheme has now been approved and will come into force from 1 January 1962.

Any member of the Institute of Petroleum may apply to the General Secretary to continue his membership of the Institute at an annual subscription of £1 1*s* 0*d* per annum, whilst continuing to receive all the rights and privileges of full membership, providing the following conditions are fulfilled:—

(*a*) The member must have retired from full employment in the industry.

(*b*) The member must be 65 years of age and have been a member of the Institute of Petroleum for a period of not less than 20 years.

# International Oil Prorationing

Following the reduction in Persian Gulf posted crude prices in August 1960, representatives of Iran, Saudi Arabia, Kuwait, and Iraq, the four governments directly affected, together with Venezuela, met at Baghdad and announced the formation of the Organization of Petroleum Exporting Countries (OPEC). The preamble of the Resolution pointed out that oil income was essential for both current and development expenditure, that oil was expendable and must eventually be replaced by other sources of income, and that price fluctuations hampered national development. It went on to deprecate unilateral price adjustments without prior consultation between company and government, to underline the necessity for restoring the price cuts made in August and to suggest the establishment of regulations, such as prorationing, that would ensure stability of prices.

Several of these aims are based on misconceptions. The emphasis of the resolution is on ensuring price stability *i.e.* preventing price fluctuations. However, from 1948 to 1957, oil prices have been one of the most stable of all commodity prices, the annual average fluctuation from trend being no more than 5 per cent compared with 10 per cent for cereals, 14 per cent for metals, and 11 per cent for all major commodities together (for individual commodities the swings were even wider *e.g.* rubber 25 per cent, lead and zinc 18 per cent each). Middle East crude postings rose rapidly after the 1939–45 War, but were remarkably steady from 1948 until 1957, since when they have moved down a little. This would suggest that the real aim of OPEC is price maintenance, rather than price stability. It is instructive to take a brief look at other commodity agreements which have been prompted by unstable prices.

**Existing Commodity Agreements**

There are a number of international commodity agreements in existence. The main ones cover wheat, sugar, coffee, and tin, products for which market prices have often fluctuated widely. The aim of the agreements is to iron out *short-term fluctuations*, which have a serious and unpredictable effect on the income of producing countries, many of them underdeveloped, and relying heavily on such products to provide local funds as well as the foreign exchange for both current and development expenditure.

All but the Coffee Agreement (producers only) involve both producing and consuming countries. Both sides negotiate price ranges in advance for tin and wheat. The market price is maintained thereafter by the manipulation of a Buffer stock and export quotas (tin), and by the importers guaranteeing to purchase a percentage of their requirements at a price within this range (wheat). It should be added that such producer/consumer arrangements are only possible with these particular commodities because the buyers of supplies entering international trade are far more concentrated than is the case with oil, where the market is so international as to rule out such arrangements. In the case of wheat, in which there were at one stage fifty consuming countries party to the agreement, some opted out as soon as cheaper supplies became available elsewhere.

The coffee producers allot export quotas amongst themselves, based on past performance, and all production in excess of the quota has to be stored in the producing country. For the share (around one-eighth) of sugar consumption not already covered by trading agreements, a price range is determined which is controlled through export quotas and stock regulation.

Each of these agreements has succeeded in its primary aim, damping down *short-term* price fluctuations, to quite a satisfactory degree. However, they have not yet resolved the root cause, over-production, for there are now enormous unsold stocks of both wheat and coffee. It is also important to note that the agreements have no pretensions towards keeping prices fixed in the longer term, nor would it seem possible for them to do so in the face of the forces of supply and demand. A recent example of the longer term forces of supply and demand upsetting an existing agreement, which has functioned rather satisfactorily in the short term, is provided by the Tin Agreement. The tin price has recently soared through the upper limit of the Agreement price range reflecting a serious shortage of supplies. The Buffer Stock Manager's efforts to control this rise were in vain, as his stock was rapidly exhausted. The Agreement is being re-negotiated.

**International Prorationing**

Although OPEC has produced no definite plan for operating a prorationing scheme there have been suggestions that should it do so, it would be broadly on the lines of historical market share and proven reserves. There are obvious difficulties to this. First, in any system based on reserves, the Middle East would do extremely well at the expense of Venezuela. Second, the formula would have to make allowances for the entry of entirely new fields (*e.g.* Kuwait off-shore). Again, although the OPEC countries currently account for about 85 per cent of crude oil exports, there seems every prospect that they will have to face competition from such countries as Algeria, Libya, Nigeria, and the U.S.S.R. Furthermore, the increases taking place in indigenous production elsewhere mean that crude oil exports will tend to form a gradually diminishing proportion of total world oil consumption.

If prorationing is to succeed in keeping prices up, it will have to be agreed on by *all* exporters. Oil production is very capital intensive, particularly in contrast with the other commodities, and, in conditions of over-supply, the out-of-pocket expenses incurred by lifting an extra barrel are well below the long run average costs which must include overheads. It will be extremely tempting, therefore, to be the odd man out of a producers' cartel, and by shading the price, obtain a disproportionately larger market share. If a company has large investments to recover and is short of cash, selling at a price even marginally above this out of pocket cost is worthwhile, for it makes some contribution towards the overheads.

When comparing possible prorationing schemes with existing commodity agreements, it is important to realise that crude oil is not as homogeneous as some of the other commodities. Besides differences in quality, there are also great differences in cost structure between, for example, Venezuelan and Kuwaiti crude. Furthermore, where circum-

stances are favourable, crude oil production is profitable even at current price levels; it follows from this that any maintenance of crude oil prices will inevitably encourage the search for oil. If this is prevented in established oil producing areas by prorationing arrangements, the search will be transferred to other countries. This is, in fact, exactly what tends to happen where prorationing already takes place (*i.e.* in the U.S.A. and Canada).

Finally, there is the possible adverse reaction of consumer countries to any suspicion of price maintenance. An almost certain outcome would be the promotion of other energy sources, such as coal and nuclear power, together with money and effort being diverted from the traditional producing countries to the search for local oil resources. In the case of coffee, which is covered by an Agreement most comparable to suggested schemes of international oil prorationing as it is formally between producers only, substitution is considerably less likely, the difference between tea and coffee being far greater than between coal and fuel oil. Moreover the production costs of coffee do not vary as widely area by area as those for oil, nor is there as much incentive to invest in coffee as coffee prices have fallen about 60 per cent since their 1954 peak. In further contrast to an international oil scheme, the present coffee Agreement covers virtually all the actual suppliers of the main grades of coffee, and these are dominated by one major supplier capable of powerful retaliatory action against the "odd man out" (Brazil produces about two-thirds of world coffee output).

**Existing Prorationing Schemes**

Study of the mechanics of existing schemes for controlling over production of oil are not of much assistance in designing a suitable international agreement. Prorationing is practised in some states of the U.S.A., notably Texas, and also in Alberta, Canada. Crude oil production in Texas has traditionally been in the hands of a large number of mainly small companies, whereas outside the U.S.A. crude oil production is mainly in the hands of fewer and larger companies. In the special circumstances in Texas uneconomic and wasteful production practices were widespread, leading to a very considerable potential surplus crude oil production and inevitably to a most serious collapse in crude oil prices.

The object is more to prevent waste than to control price, and it is interesting to note that the prorationers have lost market position and at the same time seen the price of crude fall gradually since the war, when compared with price levels in general. A further point, already mentioned above, is that the system encourages producers to develop surplus capacity in order to increase their prorated share of the market. The result is, to take the case of Texas where prorationing is enforced on all producers, that the allowable output is at present equivalent to only eight days full production a month.

**Fifty-fifty in Context of Other Commodity Producing Industries**

The instructions given to the staff of OPEC, following the members' second meeting at Caracas in January, included a request to compare investment in oil with investment in other industries, bearing in mind their supposition that oil companies' production profits are unjustifiably high.

The immediate comment on that is that at present the integrated companies' profits are mainly concentrated in the producing function, in as much as the others, especially marketing, often operate at or near a loss. Thus a 50/50 share of the producing profits provide the host governments with a very sizeable proportion of the *integrated* profits of the international oil companies.

A pilot survey into the position in other commodity producing industries has shown the tremendous difficulty in drawing fair comparisons. A major point to bear in mind when considering integrated industries is the level of the transfer price, which often appears artificially determined, and is unlikely to relate to the forces of free competition alone. Many other factors have to be considered including the scale of capital investment, the risk involved, subsidies and home country tax relief, acceptability of soft currency payments, the bargaining strength of the industry and the government relative to rival investors and alternative sources of the raw material, and the availability of substitutes such as synthetic for natural rubber.

**Conclusions that Can be Drawn**

It seems that any attempt to share out the market by a formal scheme is unlikely to succeed, partly because of the great difficulty of trying to resist economic pressures without having an effective monopoly either of oil-producing areas or alternative sources of energy, and partly because of the inherent impracticabilities of international oil prorationing.

The essential differences between proposals for oil and the existing international commodity agreements are:—

(a) The oil scheme would be aimed at long-term price maintenance whereas existing Agreements mainly purport to iron out short-term price fluctuations.

(b) Oil is more capital intensive, which makes it attractive to sell at slightly over "out of pocket" expense to recover some of the capital invested more quickly.

(c) The wider variation in cost structure of oil production from area to area which encourages over-expansion of capacity in the cheaper areas and may encourage them to break away from the agreement.

(d) Oil-producing operations are still profitable, and an international agreement would encourage yet more producers.

(e) The scheme would not cover all producers and would thus provide a price umbrella to the non-participant—in effect an encouragement to increase production outside the agreement.

(f) The relative ease of energy substitution.

(g) The likely unfavourable reaction of consumers.

## COUNCIL ELECTIONS

Members are reminded that, under By-law 72, all nominations for Council Elections in 1962 must be received by the General Secretary not later than 31 December 1961.

Applications must be made on the special Council Election form, proposed by a corporate member, and supported by six corporate members. Forms are obtainable from the General Secretary.

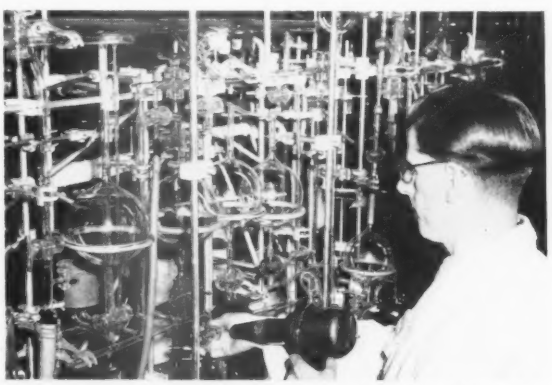
# *Industrial Uses of Radioisotopes**

By W. G. BUSBRIDGE†

With the rapid progress of science a bewildering variety of new tools is becoming available to the industrialist to assist and improve his products. One which has come into use during the last 12 years is the radioisotope.

To-day, a great many of the commodities that we meet daily in our home and business lives have been produced with the aid of radioisotopes. The safety of our transport depends on castings and forgings that have been radiographed with radioisotopes; our aircraft have been tested for fuel leakage and consequent fire risks with their aid. The paper on which we write, and in the books or newspapers which we read, the steel sheet used in the buses and cars in which we ride, and the floor covering on which we walk have probably all been gauged with isotope thickness gauges. Radioisotopes affect our health, because they are used in the study of many diseases, and they have contributed to much of our knowledge of preventive medicine. The abundance of our food supply depends on selective weed-killers and pest poisons whose modes of action have been observed with the help of radioisotopes. In their industrial applications they enable the manufacturer to produce a better and a more uniform product, and to produce it more quickly. By saving manpower in gauging and inspection they reduce production costs.

It is, therefore, vital that the industrialist should be aware of their potentialities and should know what they can contribute to his industry.



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*A laboratory at the Atomic Energy Research Establishment at Harwell where radioactive gases are handled and separated. They are of great use in the measurement of flow and leakage in gaseous fuels and in testing of thermostats and other control instruments*

**The Nature of Radioisotopes**

Radioisotopes are radioactive forms of the common elements. By placing materials such as iron, sodium, phosphorus, copper, etc., in the atomic reactor they are made radioactive and emit radiation which can be detected with fantastic sensitivity with instruments such as the Geiger counter. At the same time they retain their normal chemical and physical properties.

They can be used for studying flow, leakage, and movement of material in the same way that a coloured dye can be made to show the movement of liquid, but the radioisotope has the advantage that it can be "seen" through the walls of a vessel or a pipe, and that it can be detected or measured in quantities of a millionth or less of those required for orthodox techniques. Radioisotopes are available either as elements or in a large variety of chemical compounds, and in the form of solids, liquids, or gases, so that their versatility is immense.

A further variety of applications are based on the radiation emitted by radioisotopes. The absorption of this radiation by matter can be measured by appropriate instruments, and so a number of different kinds of gauges are at our disposal for the measurements of thickness of sheet material, of plating, of paint films, of the depths of liquids, of the depth of filling of cylinders or packets, or the thickness of the walls of pipes, vessels, and ships hulls which may have been thinned by corrosion.

Radiation has the property of producing a developable image in a photographic emulsion, and so a pellet of radioactive material can take the place of an X-ray set for photographing faults in castings, forgings, or welds.

**Radiation**

Three kinds of radiation are generally emitted by radioisotopes, and are known by the first three letters of the Greek alphabet.

Alpha radiation consists of comparatively heavy particles, each weighing about four times as much as an atom of hydrogen, and each carrying a positive electric charge. These particles are stopped by a small thickness of matter, such as a sheet of paper.

Beta radiation is also particulate, but the particles, high speed electrons, each carrying a negative electric charge, only weigh about one seven-thousandth of the weight of an alpha particle. They will penetrate a thin sheet of metal, and have a range of a few feet in air.

Gamma radiation is an electromagnetic radiation, similar to light, radio waves, or X-rays in its nature, and has great penetrating power, being capable of detection after passing through a considerable thickness of solid material.

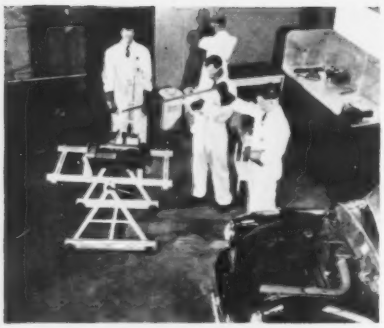
Beta and gamma radiation are the most commonly used in the industrial applications of radioisotopes.

**Half-life**

The radiation emitted by radioisotopes comes from individual atoms which disintegrate, emitting a particle and sometimes one or more flashes of gamma radiation as well. The atom is then usually stable, and emits no further radiation at all. Of the millions of atoms in a quantity of radioactive material, every one is just as likely to disintegrate as any other; it may do so within the next second, or it may be a

*Presented at a joint meeting of the IP South-Eastern Branch and the Kent Sub-Section of the Royal Institute of Chemistry on 7 April 1961.

†United Kingdom Atomic Energy Authority.



*Radioactive tracers are used to study engine wear during road tests at the BP Research Centre, Sunbury. The photograph shows the piston with radioactive ring being fitted into the cylinder block*

million years before it does so. Every radioisotope has its characteristic "half-life", which is the time in which half the atoms will have disintegrated. The term is a misnomer, because it is not a half of any specific quantity, and it could better be called "halving time". After one half-life, half the radioactive atoms remain, after two half-lives one quarter and so on. So after ten half-lives the measure of radioactivity is reduced by over a thousand-fold, and in twenty half-lives by over a million-fold.

This enables radioactive isotopes to be added to manufactured commodities with the certain knowledge that before they reach the hands of the consumer no measurable radioactivity will remain, if the isotope is one of fairly short half-life. So for additive uses, or, as they are commonly called, "tracer techniques", isotopes of short half-life are desirable, while for uses where the radiation is used, as, for example, in thickness gauging or radiography, a long half-life is preferable. The naturally occuring radioisotopes, such as radium, uranium, thorium, etc., have long half-lives, that of radium being 1600 years. The most useful artificial radioisotopes have half-lives varying from a few hours (*e.g.* sodium 24, 15 hr) to a few years (*e.g.* cobalt 60, 5·3 yr).

As radioactive disintegration is an entirely chance process, no chemical change or physical process, such as heat or pressure, can alter the decay rate or, consequently, the half-life. This indestructibility of radioactivity is obviously of great value in processes involving accurate measurement, but it can be an embarrassment when radioisotopes find their way into the wrong place through spillage or accident.

**The Safety of Radioactive Isotopes**

Through their association, in the minds of many people, with the atomic bomb, a widespread fear and mistrust of radioisotopes exists, but it is not generally realized that in their industrial applications they can confer much more safety than danger. Their use in gauging white-hot metal in furnaces and rolling mills enables readings to be relayed to a distance, and avoids the necessity of subjecting the operators to intense heat and other dangers. In the form of fire alarms or gauges for fire-extinguishing liquids in installations in paint shops, or in equipment handling highly inflammable industrial solvents, they confer an immense measure of safety.

In a great many of their applications the quantity of radioactive material used is comparable with that in the hands and dial of a luminous watch. Where larger amounts of radioactivity are used, a simple code of safe practice is easily adopted, and has ensured that accidents with radiation are, compared with the hazards arising from such causes as ladders, falling loads, mechanical vehicles, and other accepted concomitants of life, infinitesimally infrequent, and hardly ever harmful.

**Industrial Tracer Applications**

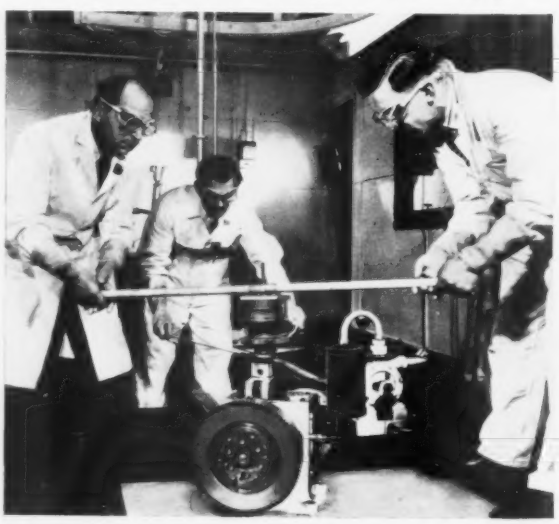
Radioisotopes lend themselves to the study of flow systems of every kind, the mixing of foodstuffs, slurries, and chemicals; the transit and leakage of oil or water in pipelines; the movement of silt under water in estuaries and dock approaches; and the calibration of flowmeters, gate weirs, and orifices.

Tracer work is usually carried out by adding a minute quantity of radioisotope to the system being studied, but in some cases it is more convenient to form the isotope *in situ* by irradiating a component in the atomic reactor. Thus, by irradiating piston rings, bearings, or cutting tools, thereby forming radioisotopes such as iron 59, the rate of wear of these components can be measured by the rate of transfer of the radioactive material to the lubricant. Such tests take only a fraction of the time taken for more conventional methods, and during this short period it is easy to maintain controlled conditions, such as coolant temperature, load, dust feed, or speed in order to obtain detailed scientific information. A great measure of advancement in lubrication and in design of internal combustion engines of every kind has been due to the use of radioisotopes.

**Radiography**

As already mentioned, a small pellet of radioactive material emitting gamma radiation can be used as a substitute for an X-ray set. The isotope source, which may be mounted in a container of lead or other heavy metal, with a lid or shutter to control the duration of exposure, is placed in front of the object to be radiographed, and an X-ray film in a suitable dark slide or cassette is placed behind the object. The radiation is attenuated by the different thicknesses of material, and so a "shadowgraph" is produced, which may show faults, flaws, or blowholes.

*Technicians engaged on research work on the evaluation of lubricating oils assembling the engine of a radioactive rig. Teamwork and practice are imperative for this operation, which requires protective clothing and special equipment*



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*A portable thickness gauge employing a radioisotope being used to measure the thickness of a pipe wall which may have been reduced by corrosion*

Such radiographic sources are in regular use in shipyards and engineering works. In addition to the safety ensured by the production of sound castings and welds, the absence of need for high voltage supplies removes the risk of electric shock in the works, and also enables the isotope source to be used in the field, as, for example, in radiographing welds and joints in pipework and cross-country pipelines.

Gamma radiographs have a valuable application to inspection of underwater welds in ships hulls, caissons, and other types of marine engineering construction, where the use of conventional X-ray equipment presents difficulties and danger of shock. A variety of isotopes is available for such work, the most popular being cobalt 60 and iridium 192. The former is suitable for iron or steel in thicknesses from 1 in to 8 in, whereas iridium is suitable for steel objects from $\frac{1}{4}$ in to $2\frac{1}{2}$ in thick. For still lighter objects, and for light metals such as aluminium, the isotope thulium 170, which emits only low energy gamma rays, will give better contrast than the isotopes of higher energy.

**Measurement by Attenuation of Radiation**

Radiation from a point source is attenuated by distance, in the same way as light, obeying the inverse square law. It is also absorbed and scattered by matter, and some of it reflected or "back-scattered". All of these effects can be used in industrial measurement.

In the control of thickness of continuously produced sheet material, from thin paper to steel plate up to 8 in in thickness, the radiation passing through the material from an isotope source is measured with a suitable electronic instrument. In the case of steel, the measurement may be made while the metal is white-hot, and the reading from the instrument relayed to the roll-spacing control to give immediate correction of thickness. Such gauges minimise the possibility of producing a long run of plate of incorrect thickness, which cannot be measured by orthodox means until the plate is cool. They also increase production speed by avoiding the necessity of stopping the mill for gauging or inspection, so that manpower is saved, bulk material goes further through the avoidance of overweight production, and the guaranteed uniformity of the material gives a higher market value.

The measurement of back-scattered radiation provides a valuable method for measuring, from one side only, metal thickness of up to about $\frac{3}{4}$ in and a portable gauge has been produced for measurement of the wall thickness of boilers, pipes, and ships hulls which may have been thinned by corrosion. Back-scattering is also useful for measuring the thickness of platings of zinc, tin, nickel, or chromium on a metallic base, and replaces conventional measurements, which involve destruction of a sample and delay in obtaining an assay. Back-scattering measurements on coal can give a rapid measurement of ash content, and can save demurrage costs on train loads of coal which normally have to await an ash assay in order to determine their suitability for metallurgical processes. The metering of pulverized coal by radioisotope gauges is another important application in fuel technology.

Liquid level gauges based on radioisotopes are used considerably for the measurement of the levels of liquefied gases, molten metals and glass, and highly corrosive liquids, and in other circumstances where conventional methods are unsuitable.

**Bulk Irradiation**

With the adoption by many countries of atomic reactors and nuclear power programmes, the facility for making radioisotopes is rapidly growing. An additional source of supply comes from the uranium fuel of the reactor, which, when it undergoes fission, breaks down into a complex mixture of radioisotopes known as "fission products". These fission products are generated in the fuel rods of the reactor, and give rise to a high degree of radioactivity which adds to the difficulty of handling the fuel rods when they are extracted from the reactor. It has, therefore, been the custom to place the fuel rods in a shielded store or a tank, in which water acts as the shield, for a time to allow the radioactivity of the fission products to decay.

For some applications it is feasible to use the radiation emitted during this period, and it is already being employed on a pilot-plant scale. It may also become economic to extract certain isotopes such as caesium 137, a gamma emitting isotope of 33 years half-life, from the fission products obtained when spent fuel is re-processed. The radiations from such materials can be used in many ways. Some chemical reactions proceed faster, and to different end-points, under irradiation, and applications to polymerization of

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*A Geiger counter at a branch in pipelines being used to detect the arrival of a fresh grade of oil, the interface being "labelled" with a radioisotope*

long-chain compounds have shown some interesting results.

Radiation, as is well known, is capable of destroying life, and although bacteria are much more resistant to it than the higher organisms, the use of radiation has been most successful in the sterilization of medical equipment such as catheters and hypodermic syringes, which are difficult to sterilize by conventional means. The use of such articles, in an expendable form, sterilized by radiation and sealed in a bag or container which is permeable to radiation but prevents the ingress of bacteria which would otherwise cause reinfection, is cheaper than conventional sterilization, and completely removes the risk of sepsis from their use. Sterilization of antibiotics, some of which are destroyed by heat, and of hospital blankets, which often carry infection and are severely damaged by heat disinfection, may become of economic value.

So far, sterilization of food has been accompanied by spoiling of flavour, and considerable work may be necessary before sterilization or pasteurization of food becomes practical and economic.

The destruction of weevils and other insects which destroy or spoil much of the world's grain has received much attention, and could compete economically with other methods, such as fumigation. Unfortunately, such methods are only applicable in countries where grain is handled in bulk, and most countries which are underfed rely on smallholdings and small-scale handling of grain. Their shortage is accentuated by economic considerations which make the transport of grain from countries which have a surplus expensive and difficult, and it is clear that these difficulties will need to be overcome before large scale disinfestation of grain can add appreciably to the world food supply or the standard of living in underdeveloped countries.

Another long-term study lies in the artificial production, by means of radiation, of genetic mutants in plants. Unfortunately, most of such mutants are inferior to the original stock, many are self-sterile, and only occasionally is a mutant produced which has a larger yield, or a higher resistance to plant disease than the original stock. The responsibility for identifying and producing new strains still, therefore, lies with the plant breeder, but radiation-produced mutants can sometimes offer new characteristics which can be incorporated in the desirable strains.

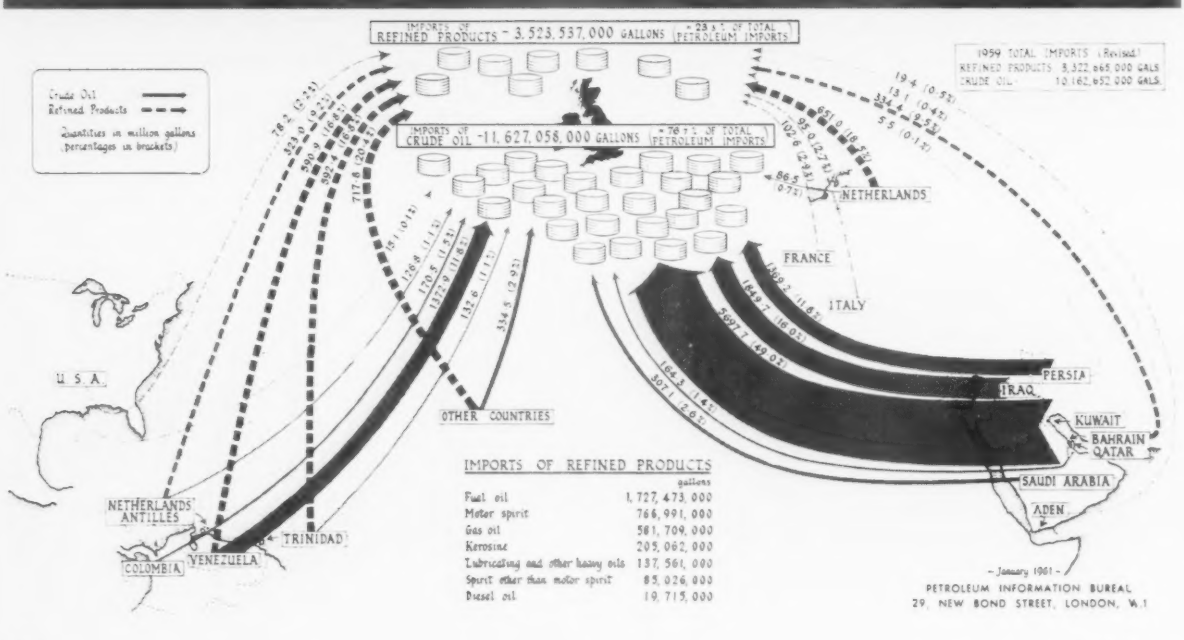
**The Economics of Radioisotopes**

Surveys have been carried out in a number of countries in an effort to assess the monetary advantages which may accrue to industry through the use of radioisotopes. The terms of such a survey tend to be rather loosely defined. Some products are made which could not be produced at all without the aid of radioisotopes. It is doubtful whether the profits from such sales should be properly included. Figures obtained from the improved production of standard commodities, however, suggest that profits obtained by the use of accepted radioisotope techniques can be many times the cost of the isotopes used.

It is apparent, therefore, that no industrialist to-day can afford to neglect to study the possible application of isotopes to his industry, and that in a time of highly competitive export trade, any country neglecting their use may find itself being left behind in the race to secure economic stability and a reasonable standard of living.

* * *

## *U.K. Imports of Crude Oil and Refined Liquid Petroleum Products*— 1960



# Notes of the Month

### Exploration in North and West Africa

Extensive exploration work has been completed this year in three countries of North and West Africa by companies in which the BP Group has a 50 per cent interest.

In the French Sahara, where BP is interested in permit areas covering a total area of 51,040 sq km, the latest deep-test well, El Allendaia in the Oued Nsa permit, has reached a depth of 12,100 ft. A drilling programme of eight shallow wells is making good progress in the Oued Amenenad permit area.

Two seismic parties, one a weight dropping "thumper" crew, are working in the central Saharan permits of Hassi Menkel, Djorf el Atfal, and El Hassine, while geological parties have been at work in the neighbourhood of Fort Polignac in the south-east and the Hassi Labbar permit area in the south-west.

In Senegal, three medium depth test wells have been drilled this year. This completed the present phase of drilling, and work is continuing on the review of the geophysical and well data gained.

In Gambia, Sara Kunda deep test well located near Bathurst has been completed at a depth of 12,200 ft.

### Shell Starting Offshore Search in Canada

Shell Oil Co. of Canada has applied for exploratory permits covering some 11 million acres of offshore lands along the western coast of Vancouver Island and in Queen Charlotte Sound. Geological surveys are expected to start shortly, and this will be the first occasion on which Shell has engaged in offshore activities in Canada.

### "Helirig" for Australian Oil Search

A "helirig", which, as the name implies, is an oil derrick that can be flown to a drilling site by helicopter, is to be used by Oilsand Pty Ltd at a drilling site in South Australia. It is believed that this will be the first time that this type of rig will have been used in the search for oil in the Commonwealth.

The "helirig" and its associated machinery will be able to drill a hole, starting at 23 in in diameter and finishing at 8½ in, to a depth of 10,000 ft. Its working load will be 300 tons.

The Company estimates that the equipment can be transported and erected, and be in use within 5 days instead of the usual 12 or more days needed for some other types of equipment.

### Developments at Kent Refinery

BP has reported good progress on the construction of new units at the Company's Kent refinery.

Work on a new catalytic reformer is going ahead and all the foundation work has now been completed. The plant will convert low-octane naphtha and benzine into high octane components for blending premium grade gasoline.

It is the third unit of this kind to be built at Kent Refinery and will be capable of processing 23,000 bd of feedstock. The two existing catalytic reformers, commissioned in 1955 and 1958, process 6,000 bd and 10,000 bd of feedstock, respectively. The new unit, which will be the biggest catalytic reformer to be built in any BP refinery so far, is due for completion early next year.

All the foundation work for the BP-California Ltd aromatics petroleum chemicals plant has been completed, and the first of five processing towers arrived at the site recently.

### Fawley Refinery's First 10 Years

It is now a little over 10 years since Fawley refinery came pn stream, and in that time expenditure on new capital olant and equipment has averaged £5½ million a year, and by the end of 1961 it is expected that total capital expenditure will have reached over £80 million. Nearly 20 per cent of the investment is devoted to the production of petroleum chemical feedstocks for the manufacture of synthetics.

During its 10 years of existence, the throughput of the refinery has increased from 6 to over 11 million tons/year crude oil. In that time 85 million tons of crude have been processed, an average of 5000 gal/min.

Tanker traffic at the refinery's marine terminal has grown to such an extent that it now represents about a third of all ships using the port of Southampton. Since the *Esso Fawley* discharged the first cargo of crude oil at the jetty in 1951, nearly 37,000 ships have berthed there. Originally 3200 ft long, the jetty was extended in 1958 by 1200 ft, and now provides five berths for ocean tankers, one of which is able to accommodate a 65,000-dw ton vessel, and four coastal tankers.

### Shell's New Canadian Refinery

The Shell Oil Co. of Canada is to build a new oil refinery in Trafalgar Township, along Lake Ontario between Toronto and Hamilton. Construction is to begin shortly, and it is expected to be completed some time in 1963.

The plant will be capable of processing nearly 10 million brl/year of Canadian crude, which will be delivered to the refinery via the Interprovincial Pipe Line. It will include units for distillation, flashing, catalytic cracking, reforming, and hydro-desulphurization, as well as crude and product tankage and the usual refinery service facilities. Among the products will be motor spirit, jet fuels, heating oils, and diesel fuels, and some specialized products to meet the needs of the Canadian markets.

The new refinery will bring the Company's refining capacity to over 130,000 bd.

### Computer Centre for U.S. Refiner

A big new computer centre, which will process inventory and delivery control, pay-roll and cost allocation, and provide scientific calculation on a refinery operation, marketing policy, and product development, has been opened in Philadelphia by the Atlantic Refining Company. The Company believes that more extensive evaluation of crude oil will now be possible, and, by simulating the results of many combinations of manufacturing processes, it hopes to develop improved refinery operations and, possibly, new petroleum products.

The new centre occupies 5000 sq ft of space. It is equipped with an IBM 704 computer, which can add or subtract 40,000 ten digit numbers every second, and can solve problems in 30 seconds which would take 15 years with pencil and paper; an IBM 7070 data processing system able to read and print magnetic tapes at ultra high speed, and to bring large files of data up to date in a few minutes; and an IBM 1401 system which will work in conjunction with each of the larger computers.

### Esso Libya Pipeline Completed

The welding of Esso Standard Libya's 172-km pipeline which will give access to the Mediterranean for crude oil supplies from the Zelten field was completed recently when the last joint of the 30-in diameter pipe was installed at Zelten. Shortly after, a valve was opened and the pipe-filling operation began.

It will take approximately one month for the pipeline to Marsa el Brega to fill with crude oil, provided there are no unforeseen difficulties.

The pipeline operations are still in the experimental stage. Temporary facilities for removing sour gas from the crude are being used, since the permanent Zelten production equipment has not been completely assembled. At the present time about 25,000 bd of crude oil, the top capacity of the present facilities, are going in to fill the pipeline.

Between now and the official opening of the Port Brega terminal later in the year, celebrating the beginning of regular exports of Libyan crude, a great deal of work remains to be done. Crude oil storage tanks at Port Brega, each of which can hold 268,000 brl, have to be completed and about 8 km of 36-in diameter pipe to carry oil from the tanks to measuring and tanker-loading facilities are to be installed.

Esso International Inc. has already announced the posted price for Zelten crude. This posting effective August 12 was $2·21 per barrel for crude oil having a gravity in the range of 39·0° to 39·9° API, delivered aboard vessels at Marsa el Brega. It is anticipated that Europe will provide the major outlet for Libyan crude. The price established reflects its proximity to the major refining centres in that area and is competitive with crude oils from the Middle East when quality and transportation factors are taken into account. Permanent tanker loading facilities at Marsa el Brega will be completed before the end of the year but some deliveries through temporary facilities will be available before that time.

### Proposed Crude Oil Line from Minagish

Work is to start later this year on the construction of a 30-mile crude oil pipeline from Kuwait Oil Company's Minagish field to the tank farms at Ahmadi.

### Abadan's New Catalytic Reformer

The construction team of 30 engineers and 480 labourers erecting the new 1 million tons/year catalytic reformer at Abadan refinery is using a 1/32 scale model as a three dimensional blueprint of the installation. This technique is becoming increasingly used in refinery construction. One of its advantages is that the model can later be used to serve as a training aid for the operators who will run the installation concerned.

The new catalytic reformer is expected to cost some £3·6 million, and is due for completion in April 1962. It will employ a platinum catalyst to convert low octane number gasoline into high octane number grade. The unit is the largest to be constructed at Abadan since the establishment of the Iranian oil operating companies in 1954.

### Possibility of a Teheran Refinery

With Iran's internal consumption of petroleum products rising by between 17 and 20 per cent each year, the problem of maintaining supplies from Abadan refinery and the major oilfields in the southern part of the country to the main areas of consumption in the north is becoming increasingly complex.

Some possible solutions to the problem were discussed by Dr A. Fallah, assistant head of NIOC's Technical Development and Research Organization, in a recent lecture.

He said that the construction of a medium-sized refinery near Teheran to supply the local consuming area, the largest in the country, would release products from Abadan refinery for export. He estimated that the cost of such a refinery would be amortized within 8 years from the commencement of operations.

He then discussed a proposed project for a second Trans-Iranian pipeline connecting Abadan to Teheran. He said that the need for constructing such a line was particularly urgent, since northern requirements will equal the total throughput capacity of the existing 600-mile line by 1962. Here again, it was considered that the cost of constructing the line would be amortized within 8 years.

Dr Fallah also spoke about the proposed 92-mile gas pipeline to carry natural gas from NIOC's northern gas field at Sarajeh to Teheran. He said that initially the gas would mainly replace fuel oil used by industrial plants, but at a later stage a pipeline network would be laid to supply domestic needs. The cost of this project, he estimated, would be amortized within 4½ years.

### Petrochemicals Expansion at Delaware Refinery

An OXO-alcohol plant with an eventual annual production of 60 million lbs/year is to be built at the Tidewater Oil Company's Delaware refinery. It will produce *iso*-octyl, decyl, and tridecyl alcohols, used primarily in the manufacture of plastic products. Other products will be added to the range later.

The project is a joint one in which Tidewater will provide raw materials and operate the plant and Air Products Inc. will provide design engineering and will be responsible for sales of products. The bulk of the initial output will go to Reichold Chemicals Inc., one of the largest manufacturers of chemicals and resins in the United States.

The plant is the third chemicals project to be announced for the refinery area. The others were a naphthalene plant, which is scheduled to start up later this year, and a carbon disulphide plant which is already in operation.

### Further Rise in Middle East Production

Middle East oil output showed a further substantial rise in the first half of this year, when production amounted to 139,183,000 metric tons compared with 127,380,000 tons in the first half of 1960. This represented an increase of 9·3 per cent.

All the leading countries achieved appreciably higher outputs, as can been seen from the following table issued by the Petroleum Information Bureau. Persia, which supplied 28,487,000 tons recorded the largest proportionate increase of any of the major producing countries in the area.

The Middle East is now producing approximately the same amount of oil as the entire world supplied prior to the 1939-45 war, and is presently contributing about one quarter of present day world supplies.

| | *Jan.–June* 1961 *metric tons* | *Jan.–June* 1960 *metric tons* | *Percentage increase* |
|---|---|---|---|
| Kuwait ... ... | 41,430,000 | 39,658,000 | 4·5 |
| Saudi Arabia ... | 33,955,000 | 29,550,000 | 14·9 |
| Persia ... ... | 28,487,000 | 24,514,000 | 16·2 |
| Iraq ... ... | 23,657,000 | 23,001,000 | 2·8 |
| Kuwait S.A. N.Z. | 4,331,000 | 3,425,000 | 26·5 |
| Qatar ... ... | 4,163,000 | 4,071,000 | 2·3 |
| Others ... ... | 3,160,000 | 3,161,000 | — |
| Total ... ... | 139,183,000 | 127,380,000 | 9·3 |

### Expansion at German Refineries

The crude throughput capacity of BP Benzin und Petroleum's Hamburg refinery is to be increased from 1·95 million tons/year to 2·3 million tons/year. This will be achieved largely by modifying existing units. The work is expected to be completed early next year.

At BP's Ruhr refinery, construction work on the second stage is now well in hand. The units being installed include a catalytic cracking unit and a bitumen plant, both of which it is expected will be completed by the end of this year. The Ruhr refinery has a throughput capacity of 4·4 million tons/year.

Latest development at the 90,000 bsd Gelsenberg Benzin A.G. refinery at Gelsenkirchen is the start-up of a 12,000 bsd UOP Platforming unit which will produce 95–97 research octane number gasoline unleaded.

The Gelsenkirchen refinery is served by the 16-in pipeline which runs from Wessel, where it was recently connected to a 25-mile branchline of the Rotterdam–Rhine pipeline.

Plans for the construction of an aromatic chemicals plant at Dinslaken, West Germany were confirmed recently by the Standard Oil Co. of California and The British Petroleum Co. Ltd.

The new venture will be operated by a newly formed partnership, BP Benzin und Petroleum A.G. und California Chemical G.m.b.H., which will be known as Deutsche BP und California.

The contract for the construction of the plant has been awarded to the German engineering and construction firm of Lurgi. Completion is scheduled for mid-1962.

Feedstock will be supplied from the adjoining BP Ruhr refinery. The plant will have a designed capacity of 14,000 metric tons of high purity paraxylene employed in the manufacture of synthetic fibres, fabrics, films, and plastics.

The Dinslaken project parallels a similar venture in the U.K. at the Isle of Grain refinery. The two ventures involve an investment of £7 million.

### Expansion at Canadian Refinery

Latest addition to Regent Refining (Canada) Ltd's Port Credit, Ontatio, refinery is a 5400 bsd Platforming unit which began operations recently.

The charge stock is heavy (200 F–350 F boiling range) straight run gasoline plus visbreaker naphtha. Feed is pretreated by a Unifining unit, which was converted from an older catalytic reformer. Product is a motor fuel blending stock with an unleaded rating of 95 research octane number.

### Seismic Exploration Vessels

The *Sea Search*, newest addition to the fleet of three ocean-going seismic exploration vessels owned by Geophysical Service Inc of Dallas, is now on a 2500-mile voyage from Trinidad to the Spanish Sahara on the north-west coast of Africa. The vessel has recently completed a petroleum exploration contract in the Gulf of Paria off Trinidad, and will perform a similar survey in the waters of the Spanish Sahara.

The *Sea Search* is a sister ship to the Company's *Sonic* and *Texin*. The *Sonic* is presently on its way through the Mediterranean Sea to a contract in the Persian Gulf and the *Texin* is working off the coast of Brazil.

All three vessels utilize the single-ship technique of marine seismic exploration, wherein all phases of the seismic exploration programme are performed aboard a single vessel. The seismometers are encased in a 2700-ft streamer which is towed behind the vessel at a speed of approximately 6 knots. Dynamite charges are automatically fired opposite the centre section of the streamer each 2½ minutes. Returning impulses are then picked up by the seismometers, transmitted through the streamer to amplifiers aboard ship where they are magnetically recorded for later interpretation. Survey locations are plotted with radar and other electronic surveying devices.

All three vessels are ocean-going. The *Sea Search* is 176 ft in length and is registered at 676 tons. The *Sonic* is 158 ft and 405 tons, while the *Texin* is 174 ft and 420 tons. The three vessels have shallow drafts and can work close inshore. All three carry auxiliary launches equipped with seismic instruments and magnetic recording for work in shallower coastal waters and up river networks.

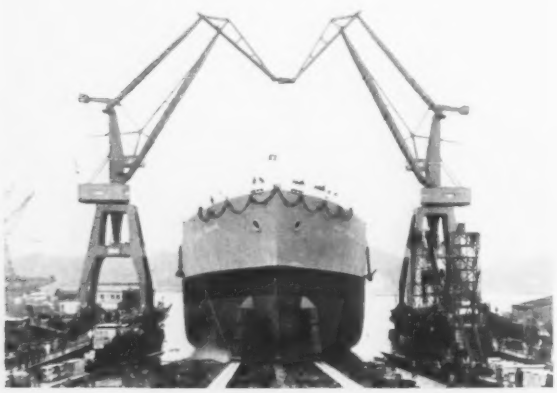
The line will be constructed in equal lengths of 22-in, 24-in and 26-in diameter pipe. It will operate on gravity flow with a capacity a little less than 100,000 bd. If it becomes necessary to increase this capacity, gas expansion driven centrifugal pumps will be installed.

Minagish lies some 21 miles west of the Burgan field, and the first oil was discovered there in May 1959. The new pipeline is due to come into operation by May 1962.

### NIOC Chairman and Directors in London

The chairman and several of the directors of the National Iranian Oil Company were in London recently for talks with representatives of the Consortium member companies.

It is understood that among the subjects discussed were the provision of facilities for increased oil production in Iran, refinery profitability, the future availability and utilization of gas, and "arrangements for the future provision of non-industrial facilities".



### Launching of the "Gulf Italian"

The *Gulf Italian*, which was launched at the Deutsche Werft shipyard in Hamburg recently under the sponsorship of Donna Vittoria Leone, wife of the President of the Italian Chamber of Deputies, is the largest tanker in Gulf's Eastern Hemisphere fleet. It is a 45,760-dw tonner, 743 ft long, with a breadth of 101 ft. It has a speed of 17 knots and a tank capacity of 2·2 million cu ft.

The new tanker, the third to be built for Gulf in the same shipyard, will be operated by the Group's Dutch affiliate, Nedgulf Tankers N.V.

Although the ship was built by German workers and will be operated by a Dutch company, its name is intended as an expression of Gulf's interest in Italy. Gulf Italia, it will be recalled, operates Ragusa oilfield, one of Europe's largest, discovered in Sicily in 1953. The field's production is currently running at the rate of 25,000 bd, and up to the beginning of June had achieved a cumulative production of 43 million brl.

The *Gulf Italian* is the second of four crude carrying tankers being built for registration in Holland. The first was *Gulf Swede*, which was launched in 1960.

### Gulf Achieves Half-Year Production Record

During the first six months of 1961, Gulf Oil Corporation achieved record production from its world-wide activities of 1,497,000 bd, compared with the previous record of 1,466,000 bd achieved during the same period of 1960. The Group's sales of refined products for the first half year averaged 881,000 bd, an increase of 32,000 bd over the first six months of 1960.

The Company's interim report to shareholders, which also records capital expenditures in the first half of 1961 amounting to $130 million, compared with $150 million spent during the first 6 months of 1960. The Group expects expenditure for the full year to reach some $390 million.

### CBMPE Chairman's Report

The chairman's report of the work of the Council of British Manufacturers of Petroleum Equipment records that British Oil Equipment Credits Ltd has, in its two years of operations, negotiated two contracts, each worth £3½ million, with Petroleos Mexicanos to provide credit for refinery extensions in Mexico.

The Company was formed by the Council to enable overseas purchasers to obtain petroleum equipment from British manufacturers on deferred terms. It is currently negotiating two other major projects with potential customers.

The chairman's report shows that oil companies resident in the U.K. placed orders for equipment in 1960 worth £119 million compared with £117 million in 1959. When orders from other sources are taken into account, the Council considers that these figures may be as much as 25 per cent higher.

At the time the report was compiled, the Council's membership stood at 518. Although the figure includes forty-nine new members enrolled during the year, it was below last year's figure of 531 members, largely as a result of mergers and the resignation of members no longer interested in the Council's field of activity.

The chairman's report reflects what was a very active year for the Council. Included in its many activities was the formation of two new committees, Petroleum Equipment Industry Standards Committee and Federation of European Petroleum Equipment Advisory Committee, a very full technical and standardization programme, and the continuance of a comprehensive news service to its members.

### Cosden Petroleum Corporation Report

In its annual report for the year ended 30 April 1961, the Cosden Petroleum Corporation records a reduction of 3 per cent in production to an average for the year of 5455 bd. Most of the Company's producing properties are located in Texas, and part of the decline is attributed to a drop in allowed producing days from 116 to 101.

An estimated 25 per cent of Cosden's income of $4,770,224, which compared with $4,763,414 the previous year, came from sales of petrochemicals against 18 per cent the year before. Refinery runs dropped by 7 per cent to 13,480,711 brl, or 88 per cent of rated capcity of its two refineries at Big Spring and Colorado City, reflecting the overall surplus in U.S. refinery capacity.

Fourteen new oil and five new gas-condensate wells were completed during the year. The Corporation's total reserves at the end of the year under review were 22,406,118 brl of crude and condensate and 74,791,397 mcf of natural gas.

### New BP Tanker

The latest tanker to be launched for BP, is the *British Prestige*, built at Vickers-Armstrong's Barrow-in-Furness yard. This new 42,000-dw ton vessel was named by Lady Robbins, wife of Lord Robbins, a Director of the British Petroleum Company.

*British Prestige* is the last in a class of seven 42,000-ton tankers built for BP in recent years.

### Industrial Screen Awards for 1961

The oil industry won two of the *Industrial Screen* awards for the outstanding internally produced industrial films in 1961. The films entered for the competition were divided into seven categories—Sales Promotion and Advertising; Public Relations; Internal Relations, Recruiting, and Indoctrination; Accident Prevention; Training within Industry; Research, Production Aids, Work Study, Technical Reports; Research Film Material.

Films entered for the first two categories had been allowed some outside help, and one of the award winners in the Public Relations section was Esso Petroleum's "Pembrokeshire my County", a magnificently-photographed documentary about the countryside surrounding the Milford Haven refinery, which was made purely as a cultural contribution and has no sales message of any kind.

Esso Petroleum also won an award in the Research category for its "Pile Casting at Milford Haven", which demonstrates a new technique in the casting of concrete piles. This film is intended for the specialist and is notable for its conciseness.

Esso's Fawley refinery is featured in "Fetch the Minuteman", an award winner in the Sales and Advertising category, which deals with the British Oxygen Company's portable life-saving equipment.

R. P. Rigg, editor of *Industrial Screen*, said at the recent press showing of the films that it is estimated that over 600 firms have their own film units, and an equal number are employing outside film makers. The competition had been organized to encourage the staff film men.

### Agricultural Chemicals Clearance Procedure May Be Re-assessed

The Association of British Manufacturers of Agricultural Chemicals recently asked the Ministry of Agriculture to review the existing Notification and Clearance Scheme by which chemicals are approved for use in agriculture.

They suggested to the Government that the scheme could be improved if the Government Advisory Committee were enabled periodically to re-assess the clearance of chemicals as new scientific data accumulates. Thus, if scientific evidence is such that the Government considered a modification or even withdrawal of the original clearance is necessary, action along these lines could be taken. Furthermore, it was suggested that the manufacturers should notify all new products, whether believed toxic or not.

### Beilby Medal and Prize

The 1961 awards of the Sir George Beilby Memorial Fund have been made to Constantin Edeleanu and Professor Jack Nutting. They each receive a gold medal and a prize of 100 guineas.

Mr Edeleanu was chosen for the award in recognition of his work on the corrosion of metals and alloys, with special reference to the development of the potentiostat technique and its applications to the study of practical problems, and on the characteristics of corrosion reaction in fused salts.

Professor Jack Nutting received his award for his work in physical metallurgy, especially in the application of the electron microscope to the study of the relationship between microstructure and mechanical metals and alloys and to the investigation of phase changes and interactions.

## LABOUR STATISTICS FOR THE U.K. PETROLEUM REFINING INDUSTRY

The following figures are taken from the August 1961 issue of the *Ministry of Labour Gazette*.
(cf. previous figures given in the *IP Review* 1961, **15**, 162)

*Figures in italics are the averages for all the industries covered by the tables.*

| | *Men* (21 *and over*) | *Youths and Boys* | *Women* (18 *and over*) | | *Girls* |
|---|---|---|---|---|---|
| | | | *Full time* | *Part time* | |
| No of workers covered by remuneration statistics ... | 19,375 | 996 | 1071 | 446 | 40 |
| Average earnings in third pay-week in April, 1961 (shillings) ... ... ... ... ... ... | 342/9<br>*301/4* | 182/9<br>*135/9* | 152/3<br>*152/7* | 91/2<br>*78/1* | —<br>*99/11* |
| Average number of hours worked in this pay-week ... | 46·9<br>*47·9* | 43·4<br>*44·1* | 39·5<br>*39·9* | 23·4<br>*21·7* | —<br>*40·8* |
| Average hourly earnings in this pay-week (pence) ... | 87·7<br>*75·5* | 50·5<br>*36·9* | 46·3<br>*45·9* | 46·8<br>*43·2* | —<br>*29·4* |
| | | | *Males* | *Females* | |
| Numbers employed (June 1961) ... ... ... ... ... ... ... | | | 32,600 | 7,200 | 39,800 |
| Numbers unemployed (at 10 July 1961) ... ... ... ... ... ... | | | 338 | 29 | 367 |

# *BP Operations in the Sahara*

The British Petroleum Group is searching for oil in the Sahara through its 50 per cent interest in the Société Saharienne de Recherches Petrolières. This company has permits covering some 50,000 sq km in various regions of the Sahara.

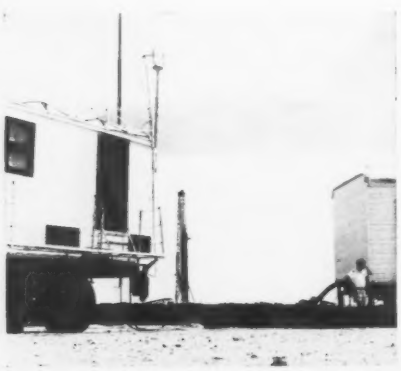
It was formed at the end of 1960 to take over the Saharan operations of Société des Pétroles de Valence, which holds exploration permits in France and is also 50 per cent owned by BP.

The Company was granted its first four permit areas in the Sahara in 1958. Geological and seismic surveys began towards the end of that year in the Oued N'sa area. The first test well was spudded-in in 1959 at El Arich el Megta in the Djorf el Atfal area in the western part of Algeria some 65 miles from the Moroccan border, and reached a final depth of 8000 ft.

In the same year the Company was granted extensions totalling 1800 sq km to three of its four areas. Early in 1960 it obtained a further 1200 sq km concession near El Barga in the East Saharan Oasis Department. A few months later exclusive permits for two areas totalling 11,740 sq km in the Fort Polignac region near the Libyan border were granted to the Company to increase its area of exploration in Algeria to 30,740 sq km. Since then it has obtained a further permit for a 19,500 sq km in an area known as Hassi Labbar, which is near the border with Mauretania and the Spanish Sahara.

The Company has completed five test wells to date, and drilling is presently under way at El Alendaia in the Oued N'sa area. Geological and survey parties are also working in several of the permit areas.

BP's partners in Société Saharienne de Recherches Petrolières are a number of French interests.



*Pictures of the Saharan oil search. The photographs at the top were all taken at El Alendaia No 1. The desert guard and sandbag emplacement contrast strikingly with the apparent calm of the scene from the drilling camp shown in the photograph on the left and the two geologists discussing Jurassic cores taken from the well. The photographs at the bottom show, from left to right, a geological party taking specimens at Hassi Labbar; the drilling platform at El Alendaia; and a seismic party in the Djorf el Atfal area using the 6000 lb "thumper", which is raised by an hydraulic system and released by an electro-magnet, falling 9 ft to create shock waves which help determine the position of underlying rock strata*

# Lectures, Courses, and Conferences

### Vacuum Science Technology

The Institute of Physics and The Physical Society is to hold a one day symposium on "Some Aspects of Vacuum Science and Technology", at Imperial College of Science and Technology, London, on 5 January, 1962.

It will cover continuously exhausted bakeable vacuum apparatus for pressures below $10^{-8}$ mm of mercury and the controlled deposition of evaporated film.

Details and application forms are available from the Administrative Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1.

### International Developments in Heat Transfer

A conference on "International Developments in Heat Transfer" is to be held at The Lecture Hall, Central Hall, Westminster, London S.W.1. from 8–12 January 1962.

It will include over 120 papers by authors from thirteen countries, and will deal principally with fundamental aspects of heat transfer. There will, however, be papers devoted to technology and others covering such fields as nuclear energy and aeronautical sciences.

The conference, arranged jointly by The Institution of Mechanical Engineers, The American Society of Mechanical Engineers, and The Institution of Chemical Engineers, is a repeat of a conference held in Boulder, Colorado, at the end of August. A preliminary programme of the London conference can be obtained from The Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.

### Welding Engineering 1962

The theme of the Spring Meeting of the Institute of Welding to be held at Buxton from 30 April to 4 May 1962 will be "Welding for Power Generation". There will be nearly thirty papers presented at the meeting, including several from overseas.

The first large scale exhibition ever organized by the Institute will be held in connexion with the Meeting. It will be named Welding Engineering 1962, and will illustrate the rapid progress of welding technology in the United Kingdom, especially in modern power generation plant construction.

### Conférence des Arts Chimiques

The provisional programme of the Conférence des Arts Chimiques, being held in Paris from 25 April to 4 May 1962, includes European meetings on chemical engineering and corrosion organized by the Chemical Engineering Group and the Corrosion Group of the Société de Chimie Industrielle, a meeting on oils, fats, and waxes organized by ITERG, a colloquium on scientific research, and technical progress; and the Jouneés de Paris, dealing with topics which will include petroleum chemistry, rubber, plastics, and prevention of atmospheric pollution.

Fuller details and registration forms can be obtained from: Conférence des Arts Chimiques, 28 rue Saint-Dominique, Paris VII[e]. Those who register to attend will be entitled to free admission to the Salon International de la Chimie, which will be held concurrently with the conference.

# SCOTTISH OIL CONSUMPTION 12·6 PER CENT UP IN FIRST HALF YEAR

Figures published by the Petroleum Information Bureau show that consumption of oil products in Scotland in the 6 months January-June 1961 reached 1,915,418 tons, some 12·6 per cent above the comparable period of 1960.

Despite the imposition of a tax on heavy hydrocarbon oils, consumption of fuel oils (excluding refinery consumption) increased by 15·7 per cent over the half year, while gas diesel oil consumption was nearly 25 per cent up.

Deliveries of motor fuel also continued to rise, and, at 299,347 tons, were 7·6 per cent higher than in the first 6 months of 1960. Consumption of derv fuel increased by 7·8 per cent to 147,657 tons.

After black oils and motor spirit, the most important product in Scotland in terms of tonnage is new chemical feedstock, of which consumption at 175,695 tons was 26·9 per cent higher than in the first half of 1960. Among other products, increases were shown in the use of bitumen (13·4 per cent to 104,995 tons) and aviation fuels (30 per cent to 98,643 tons). Lubricating oils fell by 0·3 per cent to 39,086 tons, while burning oil and vaporizing oil fell by 0·3 per cent and 19·8 per cent respectively.

Full details are given in the following table published by the Petroleum Information Bureau on behalf of the U.K. Petroleum Advisory Committee.

SCOTLAND: DELIVERIES INTO INLAND CONSUMPTION OF PETROLEUM PRODUCTS

| *Product* | *January to June* | | | |
|---|---|---|---|---|
| | 1960 | | 1961 | |
| | *tons* | | *tons* | |
| Aviation fuels ... ... | | 75,881 | | 98,643 |
| Motor spirit (incl. motor benzole): | | | | |
| Premier grades ... | 178,907 | | 208,423 | |
| Standard grades ... | 99,252 | | 90,924 | |
| | | 278,159 | | 299,347 |
| Industrial spirits (incl. industrial benzole) ... | | 36,545 | | 27,578 |
| White spirit ... ... | | 4,180 | | 4,140 |
| Kerosine: | | | | |
| Burning oil ... ... | 41,457 | | 38,976 | |
| Vaporizing oil ... ... | 15,360 | | 12,320 | |
| | | 56,817 | | 51,296 |
| Derv fuel ... ... ... | | 136,956 | | 147,657 |
| Gas, diesel, and fuel oils: | | | | |
| Gas diesel oil ... ... | 189,445 | | 235,626 | |
| Fuel oil ... ... | 458,274 | | 530,101 | |
| Refinery consumption... | 170,338 | | 176,092 | |
| | | 818,057 | | 941,819 |
| Lubricating oils and greases ... ... | | 39,185 | | 39,086 |
| Paraffin wax and scale ... | | 1,514 | | 1,516 |
| Petroleum gases ... ... | | 10,862 | | 17,160 |
| Bitumen ... ... ... | | 92,602 | | 104,995 |
| Chemical feedstock ... | | 138,486 | | 175,695 |
| Light distillate feedstock | | 11,475 | | 6,486 |
| | | 1,700,719 | | 1,915,418 |

# Books and Films

### Opportunities in Western Australia

Last year a team of nine industrialists led by J. O. Knowles, a director of Metal Industries Ltd, visited Western Australia at the invitation of the State Government. They have now prepared an independent report which draws the attention of U.K. industrialists to a vast area of the British Commonwealth which is ready for further development.

The authors envisage scope for investment by U.K. manufacturers in the field of chemical engineering and ancillary industries such as fertilizers and insecticides, plastics, paints, polishes, and medicinal preparations. They consider the establishment of a chemical engineering industry would encourage further processing before export of many of the State's abundant raw materials.

The many other investment possibilities suggested include automobile components, agricultural implements, electrical engineering, electric motors, and medium ranges of internal combustion engines.

The report also includes much general information about the State's economy of value to any industrialist contemplating manufacture or assembly there. Copies are available from the Western Australian Government office at 115 Strand, London, W.C.2.

### "Operator's Handbook"

The Gulf Publishing Co.'s *Operator's Handbook* is intended for use in training operators in refineries and chemical plants. It is based on well tried methods and has, in fact, been prepared by the Manufacturing Department of the Tenneco Oil Company of Houston, Texas.

It is illustrated and contains over 200 pages, and can be purchased from the publishers, at P.O. Box 2608, Houston 1, Texas, U.S.A., price $6.00.

### American Chemical Society's New Publication

Beginning in January 1962, the American Chemical Society is to publish a new quarterly journal, *Inorganic Chemistry*, to be edited by Professor Robert W. Parry of the University of Michigan.

The new journal will contain research articles, notes, letters to the editor, and book reviews. It will cover an area of subject matter from the borders of organic chemistry to the borders of theoretical physics. The articles will answer the question of how research was accomplished as well as why it was done and its results.

### "Oscar" for BP Film

*Giuseppina*, one of the latest BP films, has been judged the best short documentary film of 1960 by the American Academy of Motion Picture Arts and Sciences. In short, it has been awarded an "Oscar," the highest award open to a documentary film.

It is the first BP film to be so honoured, although some earlier BP films, including *Antarctic Crossing* in 1959, were nominated for the short-list for an award.

*Giuseppina* is a 30-minute colour film telling of a day in the life of a ten-year-old Italian girl whose father is manager of a service station in a village near Ravenna. The film was produced by James Hill.

### Revised PIB Memoranda

The latest of the Petroleum Information Bureau's factual memoranda sheets to be revised and brought up to date are entitled *World Production of Petroleum*, *The Growth of World Oil Production*, and *The World's Oil Reserves*.

Copies are available on request from the Bureau, 29 New Bond Street, London, W.1.

### Middle East Export Magazine

A new British export magazine entitled *Middle East Trade* and printed in Arabic is to be distributed six times a year to 5000 top level executives, government officials, and officials of semi-government agencies throughout the Middle East. It is edited by an experienced Arab journalist and published by Newman Neame Ltd.

### British Standards

*Determination of air pollution*

BS 1747, originally concerned solely with deposit gauges, is being reissued in several parts to cover, in addition, apparatus and procedure for the measurement of fine particles (smoke); gaseous impurities; and solid material.

Part 1 of the standard deals with the construction, installation, and use of deposit gauges, and includes a standard report form and a statement of the analytical determinations to be made. The standard costs 5*s* 0*d*.

*Forks, Shovels, and Spades*

BS 3388 endeavours to fix a standard preferred range of general purpose tools. Part 1, published recently, deals with nomenclature, materials, heat treatment and hardness, manufacture, dimensions, finish, and making of forks, shovels, and facture, dimensions, finish, and making of forks, shovels and spades. The Standard costs 15*s* 0*d*.

The above standards are available from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. The prices quoted do not include postage, which is extra to non-subscribers.

## MIDDLE EAST OIL PRODUCTION

The Kuwait Oil Co. Ltd's production during the first 8 months of the year averaged 1,644,523 bd.

| | *August* | *Jan.–August* |
|---|---|---|
| | *Tons* | |
| Iraq Petroleum Co. Ltd ... | 3,217,126 | 24,278,803 |
| Basrah Petroleum Co. Ltd ... | 826,321 | 6,292,968 |
| Mosul Petroleum Co. Ltd ... | 102,847 | 852,608 |
| Qatar Petroleum Co. Ltd ... | 667,861 | 5,472,208 |
| Iraanse Aardolie Exploratie en Productie Mij ... ... | 5,205,000 | 38,000,000 |
| | *Barrels* | |
| Arabian American Oil Co. ... | 42,010,815 | 336,380,415 |
| Bahrain Petroleum Co. Ltd ... | 1,396,685 | 10,975,881 |
| Getty Oil Co. and American Independent Oil Co. (Kuwait-Saudi Arabia Neutral Zone)... | 4,555,293 | 37,296,940 |

The refinery throughput at Abadan of the Iraanse Aardolie Raffinage Mij for August was 1,310,000 tons, the total for 1 January to 31 August being 9,321,000 tons.

Crude processed at Aramco's Ras Tanura refinery during August was 7,536,594 brl, the total for 1 January to 31 August being 60,040,737 brl.

# Equipment Developments

### World's Largest Balanced Boom Tanker Loading Units

Four twin 12-in balanced boom tanker loading units, which have been engineered and built by Woodfield Rochester Ltd for the Basrah Petroleum Company's deep water terminal at Khor-al-Amaya off Fao, are claimed to be the largest ever made for tanker loading duties.

Each unit weighs over 80 tons, and comprises a counterbalanced boom of all welded tubular construction pivoted upon a tubular column. A ball bearing slew ring at the top of the column permits the boom to be luffed within the range of 70° above horizontal to 40° below horizontal, and to slew within a range of 110°. The luff motion is controlled by a wire line anchored on the jetty deck *via* a return block. This line, together with secondary hose lines, is actuated by a five-drum winch of electro hydraulic design which is positioned in the tail of the boom to give maximum counter balance. The slewing motion of the boom is powered by a separate electro hydraulic mechanism.

The Khor-al-Amaya terminal lies some 20 miles offshore in 70 ft of water in the Arabian Gulf. It has an overall length of 1300 ft, and consists of a large central island and two smaller structures at either end. Two loading units are located either side of the central island to give a maximum loading capacity of not less than 7000 tons/hour per berth.

An automatic luffing device allows the loading units to be left unattended during loading, and actuates the boom at every 6 ft rise or fall of the tanker. This is achieved by a series of flameproof switches operated by cams, the motion being transmitted to the cams from the tanker manifold connexion of the main hoses, *via* a nylon signal line tensioned in the boom by a spring reel. Movement of the tanker rotates the spring reel and operates the cams.

The main crude oil transfer pipes comprise a 20-in diameter riser within the main column, bifurcating into two 14-in diameter tubes forming the outer lower members of the boom. These converge at the head of the boom through swivel elbows from which are suspended two 45 ft long smooth bore loading hoses of 12-in diameter. These terminate in special swivel joints and elbows for connexion to the tanker manifold at elevations 37 ft above jetty deck level down to 18 ft below jetty deck level at horizontal distances from manifold to berth face of from 9 ft to 30 ft.

The units operate in pairs from a common control point located 40 ft above jetty deck level, whilst duplicate controls are positioned adjacent to the foot of the main columns at jetty deck level.

The units, which were designed by Rendel, Palmer, and Tritton, are designed for a normal operational wind load of 7½ lbs sq ft, and special locks are provided between the boom heel and the main column to withstand gales of up to 120 mph.

### The Charrington Meteroil System

In operation for the first time in the U.K. at Wren Properties Rectory Green Housing Development at Beckenham, Kent, is the Charrington Meteroil System. This provides full central heating and domestic hot water for 16 houses from one 3000-gal storage tank positioned out of sight of the residential area but readily accessible. A constant supply of fuel will be made available by Rectory Green Management Ltd and will be purchased at bulk rates, a saving which will be passed on to the householder.

The fuel is gravity-fed through underground pipes to each house and can be controlled by means of stop-cocks. The supply to each boiler is recorded by VAF meters, which Charringtons have introduced into Britain.

Delmore No 60 oil-fired boilers, capable of a maximum output of 64,000 Btu/hr, have been installed in the houses. Each boiler has an electrical control panel with a time clock and thermostat.

### First UOP Lomax Unit on Stream

The first UOP Lomax unit to go on stream is now operating at the Powerine Oil Company's refinery at Santa Fe Springs, California. It is designed to produce about 115 volume per cent of gasoline from refinery distillate.

In addition to converting light distillates to gasoline, the UOP Lomax process also converts various other distillates, from kerosine to heavy vacuum gas oil, into either gasoline or a combination of gasoline and middle distillates.

The Lomax unit at Powerine has expanded gasoline output of the refinery without the conventional increase of heavy fuel and diesel oil production. It is designed to produce 2537 bsd of $C_4$ plus gasoline from a combined feed of 440–656 F boiling range diesel fuel and 200–524 F thermally cracked naphtha. Nominal charge capacity is 2200 bsd.

Hydrogen required in the fixed-bed process will be supplied by existing Platforming capacity plus a new UOP Platformer built concurrently with the Lomax unit. Lomax product in the $C_5$-$C_6$ range is blended into high octane motor fuel. Dehexanized gasoline is upgraded by Platforming.

### Improved Valve Positioner

The Fisher Type 3560V/P valve positioner, shown for the first time in Europe at the Mesucora Exhibition in Paris, is now in production at the Rochester, Kent, factory of the Fisher Governor Co. Ltd.

This completely new instrument is claimed to have a frequency response superior to that of the Type 3500, which it replaces. Its break frequency at 5 per cent of full instrument pressure range has been improved from 0·15 to 3·9 cycles/sec.

*The Fisher Type 3560V/P valve positioner with cover removed*

# Trade News

### Heat Transfer Medium

*Thermex*, I.C.I's brand of the eutectic mixture of diphenyl oxide and diphenyl, is the subject of a new brochure published by the Company's Heavy Organic Chemicals Division. This heat transfer medium is said to be suitable for applications at temperatures up to 400 C. Copies of the brochure are available from the Company's head office, Millbank, London, S.W.1.

### Industrial Chemicals

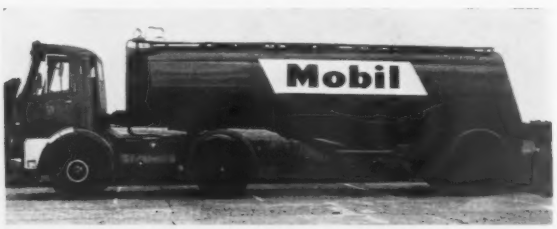
*Eastman Chemicals in Europe*, a new booklet available from Kodak Ltd, Special Chemicals Sales Department, Kodak House, Kingsway, London, W.C.2, lists the current range of Eastman and Tenite products. The Eastman industrial chemicals listed include: neopentyl glycol, polymeric plasticizer NP-10, sucrose acetate *iso*butyrate, triethyl phosphate, and Eastman 910 adhesive, which sets by a polymerization reaction that takes place when it is pressed into a thin film between two surfaces.

### Engineering and Equipment

Entitled *Worldwide Service to Industry*, a new leaflet from Plenty & Son Ltd gives a brief introduction to the equipment and services offered by the Company, the address of which is Eagle Iron Works, Newbury, Berkshire.

### Changes within the Smiths Group

Co-ordination and rationalization of marine, aviation, and industrial activities in the Smiths Group of companies means that Kelvin & Hughes Ltd will now become the Kelvin Hughes Division of S. Smith & Sons (England) Ltd. Its Barkingside factory will form part of the Kelvin Hughes Division, concerned principally with marine products, and the Basingstoke and Hillingdon factories will be incorporated in the new Aviation Division and the existing Industrial Division respectively.




*The latest addition to Mobil's road tanker fleet has a 3600-gal, three-compartment lagged lubricating oil tank trailer manufactured by YEWCO of Bradford, coupled to an A.E.C. Mandator tractor, which has an 11·3 litre diesel engine. Carrimore four-in-line air suspension is used on the trailer and the tank is internally lined with* Tanclene. *The vehicle is the 22nd four-in-line vehicle to join the Mobil fleet in the past 12 months*

### Polyurethane Rubber Development

*Urethane Chemicals Literature No 6*, available from I.C.I. Dyestuffs Division, Imperial Chemical House, Millbank, London, S.W.1, gives data on processing of the new *Daltoflex Suprasec M* rubbers, together with tables on the physical properties of typical cured compounds.

### Fuel Oil Filter

A new *Kingsway* fuel oil filter for pressure jet and vaporizing oil burners has been introduced by R. F. Landon & Partners Ltd. The filter medium is a resin-impregnated high density paper which gives a filtration efficiency of 98 per cent.

The high density paper used in the filter means that a large quantity can be compressed to give maximum filtration area within a cover of conventional size, giving greatly increased firing hours before replacement is necessary. The nominal rate of flow is 5 gal hour. The filter type FF104 consists of a diecast aluminium alloy body, a compressed steel cover with two bolts, the filter element, and vent plugs.

### Contract for Coating Neutral Zone Pipeline

A contract for coating approximately 45 miles of the 12 in, 14 in, 16 in, 26 in, and 30 in underwater pipeline system of the Arabian Oil Company in the Neutral Zone with coal tar enamel and concrete by machine method has been awarded to The Contracting and Trading Company (Kuwait).

### Tank and Plant Builders Form New Division

Whessoe Ltd, the Darlington tank and plant builders, has been re-formed into five Divisions. There are three operating Divisions: Heavy Equipment, Light Products, Engineering Services; and two Service Divisions: Research and Development, and Finance and Administration.

The Light Product Division is at present building a factory in the Calais area which is due to be opened in the Autumn, and a subsidiary company is being formed in Nigeria to carry out contracts which have been secured for construction in that country.

### Equipment Company on the Move

Materials Handling Equipment (Great Britain) Ltd has moved production and key personnel from the Maidenhead works to the larger works of the Hunslet Engine Company at Jack Lane, Leeds, Yorkshire. In addition, the London and Maidenhead offices of the Company are being merged and are now located at Hunslet Group London offices at Locomotive House, 30 34 Buckingham Gate, London, S.W.1.

### Cyclone Separators

Following the development work in connexion with the Company's gas cleaning equipment and wet dry plate and tube precipitators, Head Wrightson is now offering a full range of high performance cyclone separators varying from standard units to "tailor-made" separators for special applications. The type of equipment available is described in a new booklet available from the Company at Ship House, 20, Buckingham Gate, London, S.W.1.

### New Anglo-Arabian Engineering Consultants

An independent Anglo-Arabian consulting engineering partnership, Pencol Mid-East, has been registered in Beirut, where it will undertake all types of civil, mechanical, electrical and chemical engineering work associated with petroleum, chemical, and industrial projects.

### Fuel Oil Pre-Heat Indicator

The Shandon Scientific Co. claims that with its new fuel oil pre-heat indicator viscosity determinations normally requiring laboratory facilities can be made in 3 minutes by unskilled personnel. The correct pre-heat temperature required is read directly from a clearly marked scale and no calculations are necessary.

The instrument consists, basically, of a steel cylinder, approximately 1⅛ in diameter · 9 in high, standing erect upon a special levelling base and fitted with a perforated plunger carrying the scale rod, which projects above the screw-top of the cylinder, the fall of the plunger in the cylinder being controlled by a cam, operated by an oil-filled "falling-ball" timing mechanism.

The rod carries five separate scales, for atomizing viscosities of 75, 110, 155, 200, and 400 seconds Redwood No 1 respectively. Pre-heat temperatures for oils of a further seven atomizing viscosities can also be read from a simple chart.

### Elapsed Time Meter

A new elapsed time meter for recording the time a piece of equipment has been in use can be applied to any equipment used intermittently and on which planned maintenance or time log is required. The meter is normally connected so that it is automatically switched on and off with the apparatus being metered, and it can register up to 9999·9 hours in steps of 0·1 hr.

The cyclometer is driven by a self-starting, non-reversing, synchronous motor, through a train of gears. Operation is on ac supply in the voltage ranges 100–125, 200–250, and 400–440. The frequency can be 50 or 60 cycles.

### Rocal "Molytherm" Grease

Rocol *Molytherm* grease, which is recommended by the makers for continuous service above 350 F and withstands long periods above

450 F and short periods up to 550 F, is described in Publication No 17 which is available from Rocol Ltd, Rocol House, Swillington, Leeds.

### Danish Refinery Contract

The award of the contract to build Gulf's first European refinery at Stigsnaes, South West Zealand, Denmark, has been awarded to the Kellogg International Corporation of London. The refinery will process 1½ million tons/year of crude oil and it is expected to come into operation by end of 1962.

### Petrofina Extension at Sunderland

Petrofina (Great Britain) Ltd has awarded a £234,000 "package" contract to William Press & Son Ltd for the design, supply, erection, and commissioning of distribution facilities and doubling the storage capacity, at the Company's Sunderland installation.

The scheme involves the construction of seven large overground tanks, facilities for marine bunkering, road and rail loading, and an administrative building.

### Automatic Analysis for French Fast Reactor

The system for automatic digital analysis of measurements for the test model of the French Atomic Energy Organization's "Rapsodie" fast reactor, will record 200 different temperatures and stress values with a cycle rate of 0·2 sec. The system was designed and built by Compagnie Européenne Electronique.

### Houdry's Italian Project

The Houdry Process Corp of Philadelphia and Compagnia Internazionale Generale Industriale-Malatesta, S.p.A. have formed a joint company to manufacture and sell polyurethane foam and foam products. The new firm, Montecassino, S.p.A., is located in Cassino, Italy, where manufacturing is expected to start later this year.

### Polypenco Publications

Three new publications issued by Polypenco of Welwyn Garden City deal with *Fluorosint*, a reinforced TFE resin which, it is claimed, offers substantial operational advantages over conventional PTFE in its performance at elevated temperatures; *Nylatron G.S.*, a molybdenum disulphide filled *Nylon* 66 which is said to exhibit superior mechanical and bearing properties whilst maintaining the electrical and chemical characteristics of nylon; and *Nyaflow* flexible pressure hose, a highly flexible high pressure hose of all-bonded construction with a nylon inner core.

### Varnish Coatings

While continuing to market Rocol *Molytox Plus* as a general purpose varnish, Rocol Ltd is now also listing *Molydite Plus*, based on a thermo-setting resin as bonding agent. This new grade is said to give a tougher bonding, but requires more care in application and baking at the comparatively high temperature of 200 C.

The two varnishes are described in Leaflet I.F.S. 111 available from Rocol Ltd, Rocol House, Swillington, Leeds, Yorks.

### Big Polish Contract for CJB

Constructors John Brown Ltd, has landed a £2 million contract from Polimex, the Polish Government trade organization, for the design, supply, and installation of three tonnage oxygen and nitrogen plants for the production of ammonia at Tarnow in the South of Poland. The Company's engineers will supervise the erection and commissioning of the plants, which will be completed successively during the next five years.

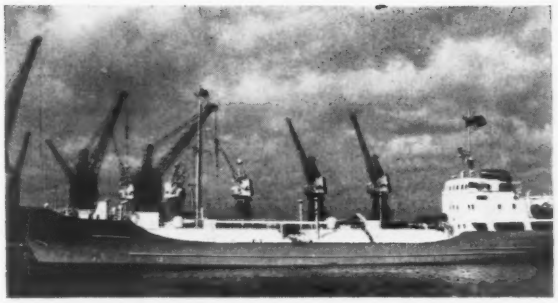
### Computer Control for New Acetaldehyde Process

A computer-directed control system ordered by Celanese Corporation of America for its new multi-million-dollar acetyl manufacturing plant being built at Bay City, Texas, will embody a Honeywell H290 high-speed digital type computer and compatible electronic instrumentation, including a computer programming console, a centralized instrument board, an alarm printer, and other equipment.

The system will perform on-line monitoring and control of a new process for producing acetaldehyde using ethylene gas and oxygen as raw materials. The process has been licensed to Celanese by Aldehyd G.m.b.H., a German company owned jointly by Farbewerke Hoechst and Wacker-Chemie.

### Change of Name

The name of Drayton Regulator & Instrument Co. Ltd, has been changed to Drayton Controls Ltd.



*The* 800-*ton* Lili Tholstrup *is the latest and largest vessel to join the fleet of LPG tankers owned by A/S Kosangas of Copenhagen. The vessel is capable of refrigerating its own cargo, and like other vessels in the same fleet will be used to transport butadiene for I.C.I.*

### Data Sheets on Tube Products

Its range of small-bore tubes and tube products is described in a new series of data sheets from Johnson Matthey. The tubes are available principally in non-ferrous metals and alloys, although grades of nickel-iron alloy are supplied, as well as tubes in precious metals for specialized applications.

Sets of data sheets are available from the Company at 73–83 Hatton Garden, London, E.C.1.

### Water Stripper with Silicone Treated Filter Papers

A new water stripper element, the *Fram C.S.*15, designed to meet the pressure differential requirements of specification MIL–F–8508A, is reported to withstand a differential pressure of 75 psi and will resist pressure shocks associated with a fuelling operation. The element features a new type of filter paper manufactured to produce a large number of uniformly small pores, resulting in a higher solids filtration. The paper is silicone treated to render it water repellent. Manufacturers are Simmonds Aerocessories Ltd.

### Highly Sensitive Electrical Switches

Electrical switches which signal pressures and differential pressures in the low range of 0·25 to 16 in of water column have been developed by Pall Corporation and its subsidiary, Aircraft Porous Media, Inc. They operate by means of a spring-biased diaphragm. The diaphragm senses very low pressures and at a pre-selected point actuates a rod which in turn sets off a switch mechanism. Desired actuation pressure is set by a direct reading dial. The units contain no mechanical linkages and are claimed to be immune to damage from over-pressure up to their rated capacity of 250 psi.

### Technical Literature

Technical data sheets featuring the Company's Black Dewatering Rust Preventive and *Crill S.8*, sorbitol mono-stearate polyoxyethylene derivative, are available from Croda Ltd., Cowick Hall, Snaith, Goole, Yorkshire. The Company has also published a *User's Digest* containing new data on the use of its products in industry.

### U.K. Marketers for U.S. Product

*Unitrace*, manufactured by Aluminium Company of America, which is designed for use in the processing of chemical and food products where liquids must be kept warm to prevent solidifying when being pumped from one location to another, is now being marketed by Imperial Aluminium Co. Ltd. It is an extruded aluminium alloy tube combining two integral channels, the larger for the product line, the smaller for the tracer line carrying the heating or cooling medium.

### New Unit for Strasbourg Refinery

Contractors for the new atmospheric unit and gasoline treating unit to be built at the Strasbourg refinery are PIC Engineering. McKee Head Wrightson of London will provide process design, basic mechanical design, and general supervision services to PIC. The unit is designed to process 3,300,000 tons/year of Hassi-Messaoud and Iraq crude and is scheduled for completion by early 1963.

### Redesigned Continuous-flow Refractometer

The Hilger & Watts continuous-flow refractometer has been redesigned in three separate versions for different applications. *Type M 540* is a self-contained rack-mounted unit for use in temperate conditions where the atmosphere is clean and the pressure normal; *Type M 541* has its measuring unit in a special industrial case protecting it from dirt, humidity, and oil vapour; while *Type M 550* is a bench-mounted model in which sample cells are filled through a funnel making it suitable for rapid batch working in test laboratories.

### Condensing Plant for West Thurrock

The order for the supply of condensing plant for use with a 30 MW turbo-generator at West Thurrock power station has gone to the Richardsons Westgarth Group. It is worth some £300,000.

### New Technical Leaflets

New technical leaflets describing vapour pressure thermometers and a physical type dissolved oxygen analysing meter are available from The Cambridge Instrument Co. Ltd, 13 Grosvenor Place, London, S.W.1.

### Industrial Maintenance Coatings

An industrial handbook designed for people concerned with maintenance painting is available from Camrex Paints Ltd, Camrex House, Hudson Road, Sunderland. Its 56 pages describe the complete range of the Company's paints, their uses, and methods of application.

### Zone-Refined Tellurium

Zone-refined tellurium of high purity is now being produced by Johnson Matthey. The total metallic impurity content, excluding selenium, is less than 5 ppm and is normally in the region of 1 ppm. The selenium content does not exceed 5 ppm. It is supplied as half-round bar approximately 1 in × ½ in.

### New Road Map of London

The new road map of Central London and the approaches to London which was published recently is the final sheet in the new series of Shell and BP Road Maps of the British Isles. Central London is shown in detail on one side of the sheet in a large 5 in : 1 mile scale. The reverse side has a ¾ in : 1 mile scale of the approaches to London.

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**FOR SALE**

**WATERFOG and Waterspray Installations,** automatic or non-automatic, designed and installed for Fire Fighting. Also complete Foam Installations. Fire Armour Limited, 9 George Street, London, W.1.

**SITUATION VACANT**

**Graesser Salicylates Ltd.,** Chemical Manufacturers, Sandycroft, Near Chester, require a **Development Engineer** with experience in Chemical plant erection, operation and maintenance. Applicants must hold an honours degree in Chemical Engineering or an equivalent qualification. Good prospects. The Company operates a non-contributory Pension Scheme. Please apply in writing to The Managing Director.


# Forthcoming Meetings

### THE INSTITUTE

(*At* 61 *New Cavendish Street, London, W.*1, 5.30 *p.m.—tea* 5 *p.m.*)

**Charge Relaxation in Hydrocarbon Liquids Flowing Through Conducting and Non-conducting Tubes.** J. A. Carruthers, D. Phil., B.Sc., A.Inst.P., and K. J. Marsh, B.Sc., A.Inst.P.

*and*

**The Estimation of Electrostatic Potentials, Fields, and Energies in a Rectangular Metal Tank Containing Charged Fuel.** J. A. Carruthers, D.Phil., B.Sc., A.Inst.P., and K. J. Wigley, B.A. **6 December**

**The Technologist and His Information Facilities.** R. Snel (Joint IP/ASLIB meeting). **15 November**

### IP FAWLEY BRANCH

(*At Esso* (*Fawley*) *Recreation Club, Holbury,* 5 *p.m. for* 5.30 *p.m.*)

**Some Aspects of Psychology in Industry.** S. J. Dalziel, B.Sc. (Eng.). **6 December**

(*At the New Forest Hall Country Club, Brockenhurst*)

Dinner-Dance. **16 November**

### IP LONDON BRANCH

(*At* 61 *New Cavendish Street, London, W.*1, 6.15 *p.m.—tea* 5.30 *p.m.*)

**Presidential Address.** Julian M. Leonard, M.I.Chem.E. **23 November**

(*At Shell-Mex House*)

**Film Evenings.** **1 & 8 December**

### IP NORTHERN BRANCH

(*At Engineers' Club, Albert Square, Manchester,* 2, 6.30 *p.m.*)

**Propellants for Rocket Propulsion.** R. P. Hagerty **14 November**

(*At Midland Hotel, Manchester,* 7 *p.m.*)

**Annual Dinner-Dance.** **24 November**

(*At Old Nag's Head Hotel, Manchester*)

**Hot Pot Supper.** **12 December**

### IP SOUTH-EASTERN BRANCH

(*At the Sun Hotel, Chatham,* 7.45 *p.m.*)

**Films in the Oil Industry.** R. F. Leach. **5 December**

(*At Royal Star Hotel, Maidstone*)

**Annual Ball.** **17 November**

### IP SOUTH WALES BRANCH

(*At the Training Centre, BP Refinery* (*Llandarcy*) *Ltd,* 5.30 *p.m.*)

**Bitumen and Its Uses.** A. W. Jarman, B.Sc., A.R.I.C. **7 December**

### IP STANLOW BRANCH

(*At the Lecture Theatre, Grosvenor Museum, Chester,* 7.30 *p.m.*)

**The Role of the Factory Inspector in the Petroleum and Chemical Industries.** A. D. Sill, B.Sc. **15 November**

### IP YORKSHIRE BRANCH

(*At the Great Northern Hotel, Leeds,* 7.30 *p.m.*)

**Industrial Petroleum Gases.** K. R. Garrett. **8 November**

### IP ECONOMICS AND OPERATIONS GROUP

(*At* 61 *New Cavendish Street, London, W.*1, 5.30 *p.m.—tea* 5 *p.m.*)

**Business Decisions in the Russian Economy.** A. Nove. **9 November**

**The Petrochemical Industry in the U.K.** H. P. Hodge. **14 December**

### IP EXPLORATION AND PRODUCTION GROUP

(*At* 61 *New Cavendish Street, London, W.*1, 5.30 *p.m.—tea* 5 *p.m.*)

**Exploration and Production Research.** Dr Mooy. **7 December**

### DIESEL ENGINEERS AND USERS ASSOCIATION

(*At the Institute of Marine Engineers,* 76 *Mark Lane, London, E.C.*3, 2.30 *p.m.*)

**Presentation of Annual Report on Oil and Gas Engine Working Costs and Performance.** **14 December**

### THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS

(*Manchester and District Branch*)

(*At the Engineers' Club, Albert Square, Manchester,* 6.30 *p.m.*)

**Some Important Aspects of Oil Firing as Applied to Sectional and Shell Boilers.** N. Charlesworth, G.I.Mech.E. **8 December**

### THE INSTITUTION OF MECHANICAL ENGINEERS

(*At* 1 *Birdcage Walk, Westminster, London, S.W.*1, 6 *p.m.—tea* 5.30 *p.m.*)

**Lubrication Oil Filter Testing.** K. E. Buckman and S. W. Kemp

*and*

**A Standard Contaminant for Oil Filter Testing.** A. T. Weare. **6 December**

### THE SOCIETY OF INSTRUMENT TECHNOLOGY

(Manchester Section)

(*At the Literary and Philosophical Society,* 36 *George Street, Manchester,* 1, 6.45 *p.m.*)

**Instrumentation for Oil Fired Glass Furnaces.** N. I. Walker **13 December**

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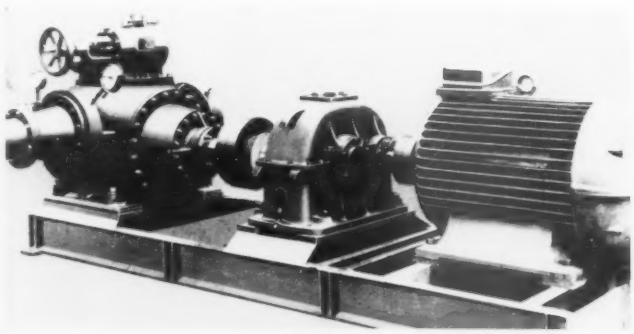

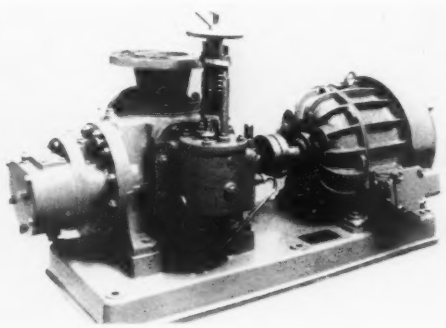

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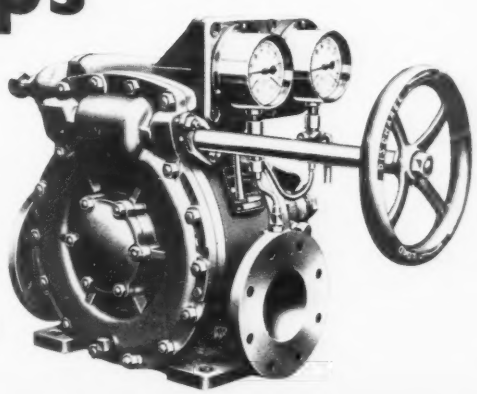
On the right is a Reversing Flow Rotary Displacement Pump for fitting on tank wagons. It is normally driven from the lorry power take-off.



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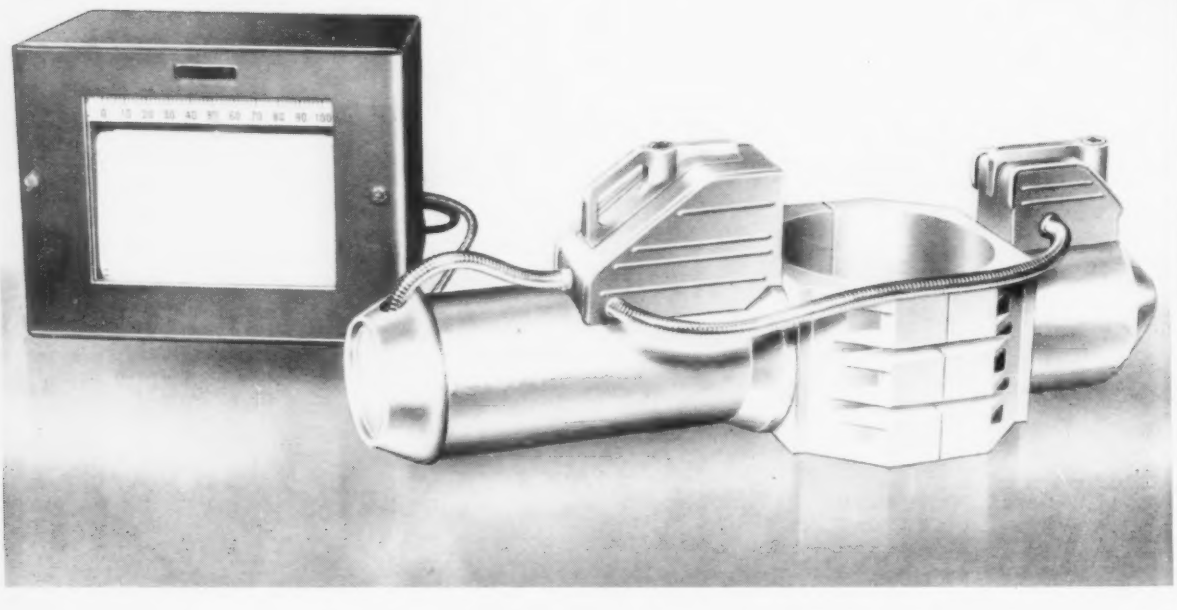

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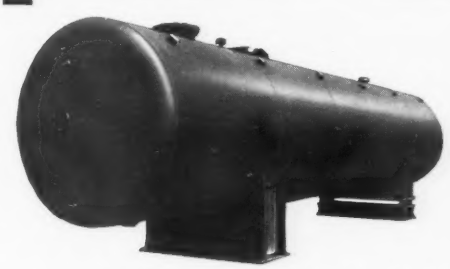

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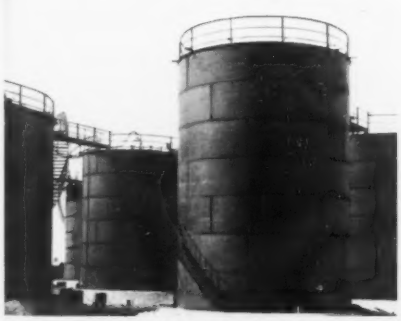
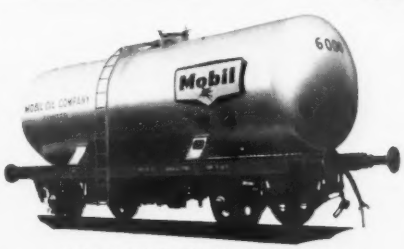


BULK TANK INSTALLATIONS, SITE AND LONG DISTANCE PIPEWORK

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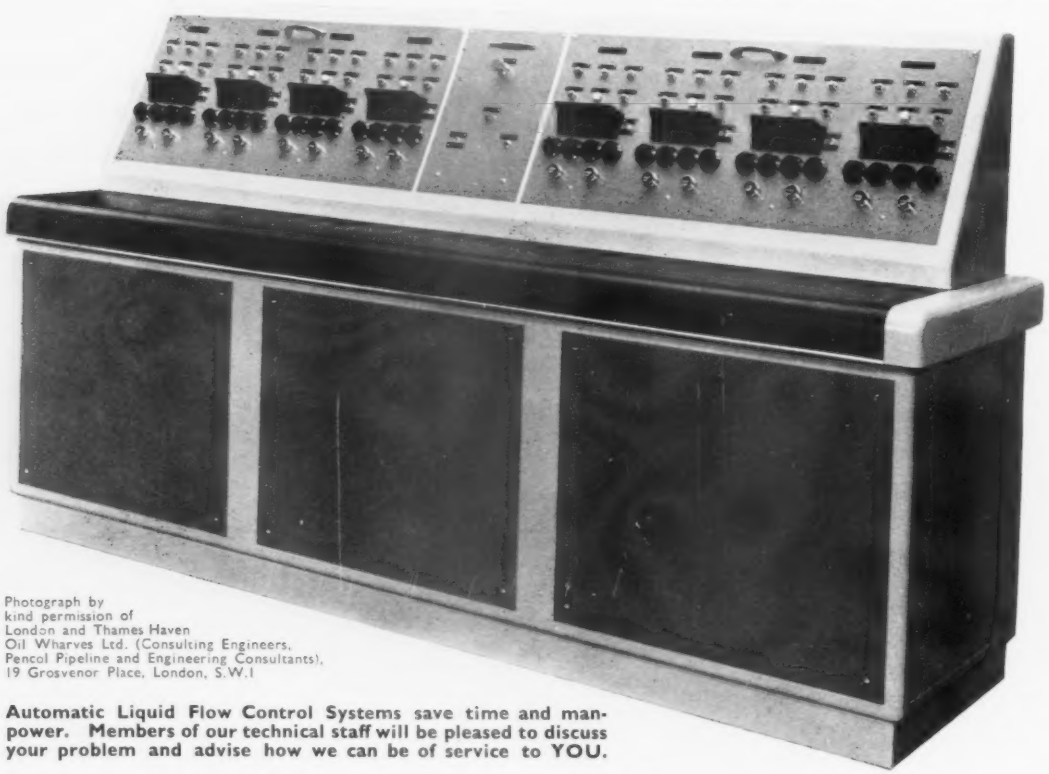

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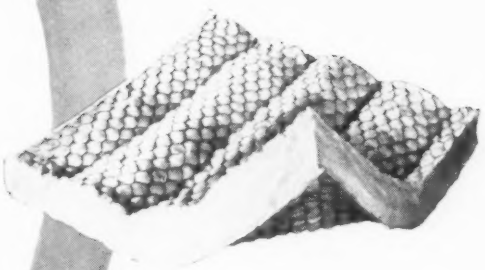

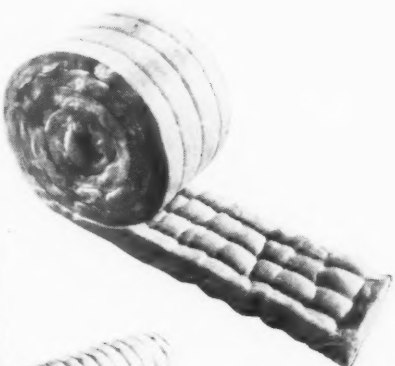

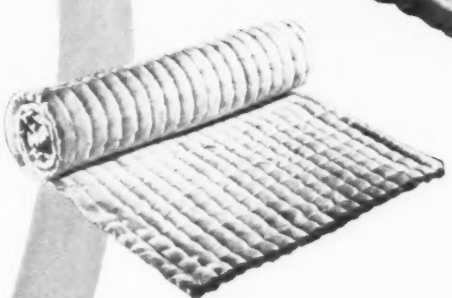

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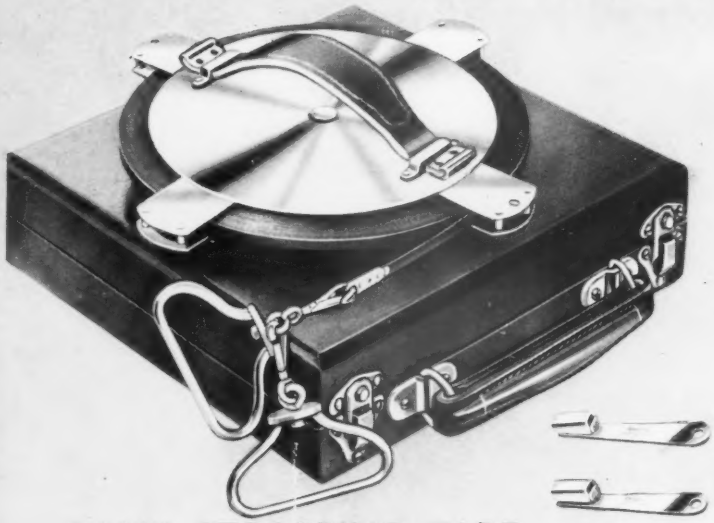
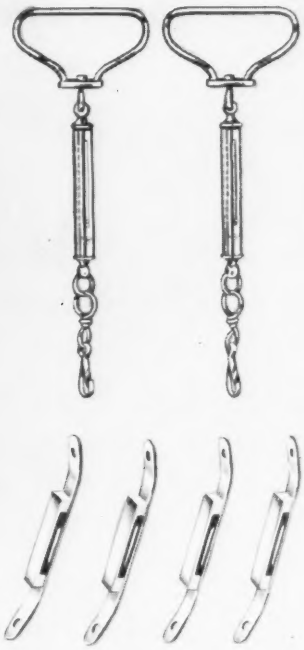
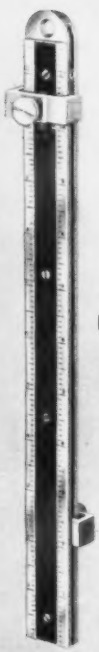


TANK STRAPPING TAPE
AND ACCESSORIES



OIL GAUGING TAPE
ON FRAME WINDER
With Nº 610 Depth Weight



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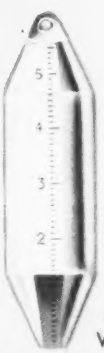

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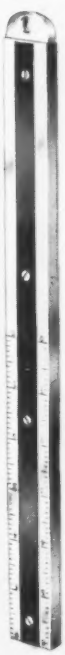

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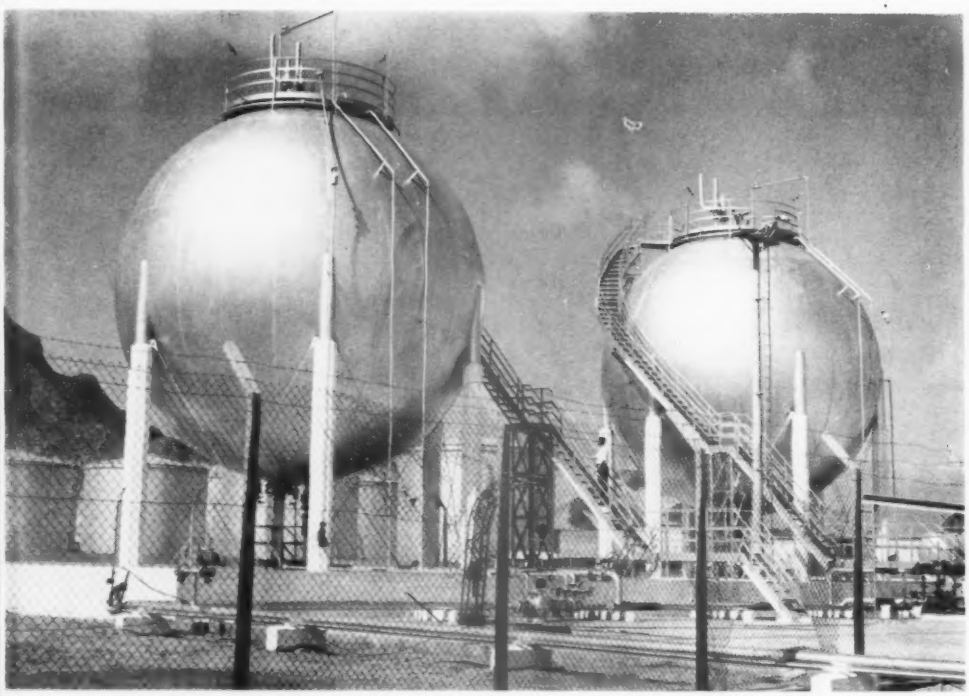

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|---|---|
| France | 1 |
| Italy | 2 |
| W. Germany | 2 |
| Great Britain | 2 |

| In course of Completion | |
|---|---|
| Holland | 1 |
| Belgium | 1 |
| Italy | 1 |
| France | 1 |
| Denmark | 1 |
| Great Britain | 7 |
| W. Germany | 3 |

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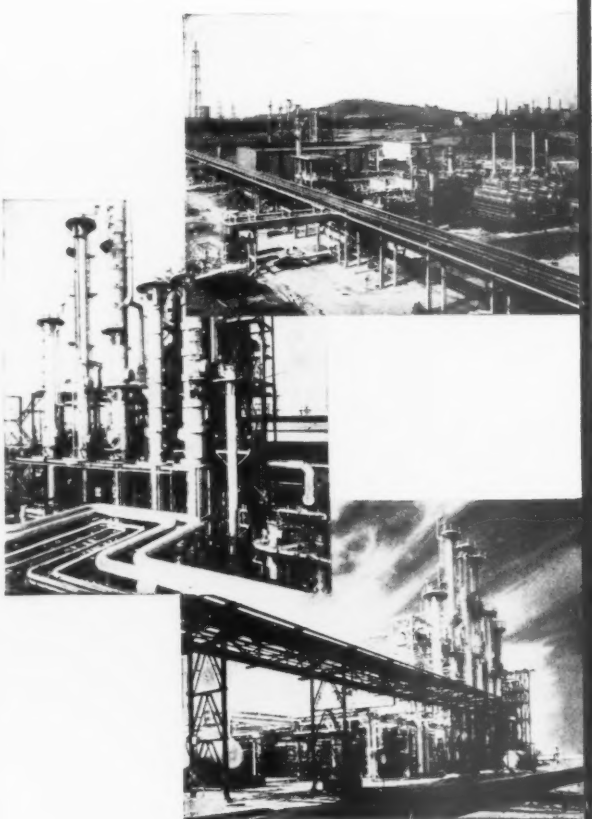

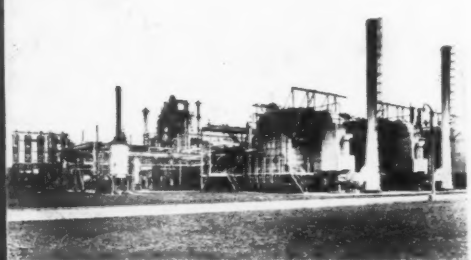

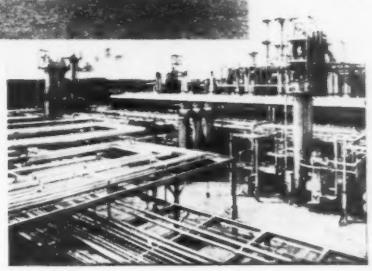

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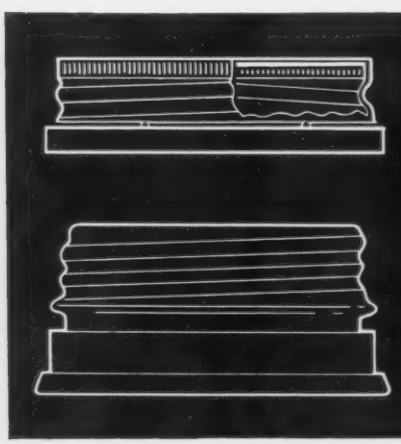

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